Physics Enrolments in Australian Tertiary Educational Institutions 1980 - 1990

AUSTRALIAN & NEW ZEALAND PHYSICIST

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CONTENTS

PRESIDENT'S COLUMN 74
The New Presidents First Column. T. Thomas

EDITORIAL 75
This Could Be Your Guest Editorial! R. J. MacDonald

LETTERS 76

CONFERENCE REPORT 77
The Fifth Forum of the National Science & Technology Analysis Group (NSTAG). R. O’Sullivan

ARTICLE 80

AIP/NZIP NEWS 88

OF INTEREST 90

OBITUARY 92
Professor Daphne Jackson OBE. A. Thomas

PRODUCT NEWS 93

BOOK REVIEWS 96

CONFERENCES & MEETINGS inside back cover

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Cover Picture: A view looking south-east across the plateau from the roof of the Aeronomy Laboratory at Mawson, Antarctica. The main structure is the periscope of the Fabry-Perot Spectrometer and the black structure in the adjoining dome is the all-sky camera. The Fabry-Perot Spectrometer, run by the Mawson Institute for Antarctic Research, is used to determine winds and temperatures from auroral and airglow emissions. The all-sky camera, run by the Antarctic Division, routinely records auroral activity across the sky.
Photograph submitted and taken by Dr. Pene Green.

Australian & New Zealand Physicist Volume 28, Number 5, May 1991

73
President's Column

The New President's First Column

Who knows, perhaps the first President's column one writes is the most difficult? There can be no doubt that Tony Klein is a hard act to follow, and all of us owe him a great deal - not only for his entertaining, incisive and at times controversial column, but most of all for his leadership over the past two years.

The past two years have included some fairly trying and dramatic events. Most prominent has been the Dawkinsisation of our state universities and CAE's. For many physics departments, this has led to even higher student/staff ratios and to an erosion of infrastructure support. As a consequence it has become much harder to conduct internationally competitive research programs. The revolution in CSIRO has continued to the point where long-term, basic research has almost been eliminated. In this period we saw too the publication of the AZTEC document, Profiles of Australian Science, with its blunt declaration that 'physics is in the parlous state of any of the fields of scientific research in Australia'. The next few years promise an even bigger dose of change. Truly we are under the curse of living in interesting times!

Most recently the red eye of the government has turned to ANU and there the Research Schools are suffering a pounding comparable to that doled earlier to the state universities. The Biological Sciences recently saw a newly appointed head change his mind and refuse an already accepted appointment. In the Physical Sciences, George Dracoulis is a first-rate appointment to the Chair in Nuclear Physics, while a second chair is on offer and hopefully will be accepted. Two of the four chairs initially advertised will apparently now not be filled. In addition, the post of Director has yet to be filled. It would be a brave soul who would move to Canberra in the present climate of uncertainty. Fine universities thrive in a stable, reassuring atmosphere, not in the midst of a cultural revolution. It's time to leave them alone!

In case the tone of this column seems to be uninterrupted doom and gloom, it is well to remember that there is a very important and potentially beneficial exercise under way this year. All members of the AIP (and all those physicists who are not yet members) should take very seriously the chance to contribute to the formulation of the Strategic Plan for Physics. If you have not done so, now is the time to begin your submission. Whatever one may think of the methodology employed in Profiles, few would dispute the main conclusion that 'physics and areas of other fields which draw on principles from physics, are particularly at risk' at the present time.

Cynics may suggest that whatever we write, nothing will change. That is of course possible, but if we do not use this opportunity it is certain that nothing will change. Please, give the system a chance. Put your thoughts on paper, circulate them amongst the members of your research community and let members of the committee (especially Bruce Metcalfe and John Collins) know of your progress. I would be pleased to receive copies of working documents from any AIP members who wish to send them.

Tony Thomas
This Could Be Your Guest Editorial!

Tony Klein has become an immediate past President of the AIP. Tony Thomas is the new President. There will be a new hand at the President’s column for the next two years (and a new person for me to remind when it comes near the time of the month for the President to pronounce).

I have enjoyed working with Tony Klein and I expect to spend an equally interesting and enjoyable eight months with Tony Thomas. The things we will write about do not look as if they will change very much. Research funding, science policy, research directions, AZTEC, CRC’s, the ARC and so on, will remain the focus of attention.

I am very conscious that, in my several years as Honorary Editor, the focus of the Editor’s column has been physics, physics research and physics education mainly in the tertiary sector. Some of the matters discussed will be of interest and concern to our colleagues in the CSIRO, DSTO, secondary school system and in industry, but my focus will always be the University sector. To balance the previous several years of editorial wanderings, I would like to invite others to offer guest editorials which might provide a different perspective on the matters which concern us. I would be particularly interested in a guest editorial from New Zealand.

I will try to excite the interest of some of my colleagues outside the tertiary sector to write for us, but don’t wait for me to come to you. If you have something to say of import to physicists, then here is an opportunity to do so. Contact me quickly, and I will assign you a date to deliver an editorial.

The AZTEC ‘Profiles of Australian Science’ painted a grim picture of physics in Australia. We can comment on the bibliographic survey and point out possible inaccuracies, but nonetheless, the state of physics in Australia is not good.

The ARC discipline and priority area panels met in Canberra recently to begin work on the 1992 funding proposals. Despite all that has been written on the ARC and the need for a higher profile for physics and chemistry in that arena, again the state of physics in Australia looks grim.

No comment is made on the quality of the proposals. Indeed assessors rate the proposals highly and, with the permission of the Chair of the ARC, I hope to bring to you some details of the overall grant application situation, perhaps in the next issue.

There was essentially no increase in the number of new proposals for the support of research in physics and mathematics for 1992. The total number of new applications went up by 18%. Biology, engineering and the humanities increased their number of initial applicants substantially. Physics and mathematics did not.

This is important because the allocation of funds to the various panels uses an algorithm which includes a factor relating to the number of quality initial proposals. As a result of the response from physicists and mathematicians, coupled with an essentially constant ARC grant budget, means potentially a lowering of the funds physics and mathematics (and chemistry) might have for distribution. It might be interesting to know why physicists and mathematicians have not applied for support. Why not try our letters column and begin a discussion of why submissions for support have not been forthcoming and what is necessary to rekindle the enthusiasm of tertiary sector physicists and mathematicians.

R.J. MacDonald
Honorary Editor

RESEARCH FELLOW
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Reference No. 14/03

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  - Tel: (02) 692 2553

- Plasma Physics
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  - Tel: (02) 692 2546

- Theoretical Physics
  - Professor D. Melrose
  - Tel: (02) 692 2533


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Engineers in higher demand

Dear Sir,

I read with interest the opinions of Professor Prescott (ANZP, March 1991) on the relative demand for scientists and engineers. Although I agree with the suggestion that Australia needs more scientists and engineers, it would appear that Professor Prescott is out of touch with reality when it comes to real employment demand: that encountered by the graduates themselves.

During the fourth year of a B.E. degree, an engineering student is inundated with mail from companies scrambling over each other to secure the student's services on graduation. At the height of the "mating season", offers flow in at the rate of several per week. Many of the companies have been in contact with the prospective graduate since the middle of their third year of study. The range of careers offered varies across a broad spectrum of both engineering and non-engineering areas.

On the other hand, a B.Sc.(Hons) Physics student receives two or three invitations during their fourth year of study, all from other tertiary institutions, inviting them to undertake their PhD in another state.

Undoubtedly there is a demand for physicists, as the 830 jobs advertised in The Australian for 1989 indicates. But to suggest that this is in any way comparable to the enormous demand shown by industry for engineering graduates is absurd. When it comes to "Australia's greatest need", industry has put their money where their mouth is and the money is on the engineers.

John Costella GradIE Aust GAIP
School of Physics
The University of Melbourne

Errata!

Dear Editor,

I don't know whether you bother with errata, but the typesetter for the Jan/Feb issue credited the Canterbury Ring Laser with a frequency resolution of 1 in 10⁹, which almost any Fabry-Perot could lick hollow. It was 1 in 10¹⁵ actually.

Geoff Stedman
CONFERENCE REPORT

SCIENCE AND TECHNOLOGY
CREATING WEALTH FOR AUSTRALIA

THE FIFTH FORUM OF THE NATIONAL SCIENCE AND TECHNOLOGY ANALYSIS GROUP (NSTAG)

Canberra, 13 - 14 November 1990

Background

NSTAG Forums are intended to provide an annual opportunity for scientists and technologists to interact directly with the Federal Government’s science advisors and administrators in analysing Australia’s science and technology performance and to make recommendations to the Government for political and administrative action.

NSTAG was established in 1986, soon after the setting up of the Federation of Australian Scientific and Technological Societies (FASTS). In addition to FASTS, it comprises the Australian Academy of Science, the Australian Academy of Technological Sciences and Engineering, and the Institution of Engineers, Australia.

The four constituent bodies organize the forums in turn and in 1990, the organizing body was the Institution of Engineers. The issues chosen for discussion as well as the speakers reflected, to some extent, the interests of the organizing body.

In accordance with a recommendation made by Prof. Ron Johnston at the 1988 NSTAG Forum, a Science and Technology Budget Statement had been included in the 1990 federal budget papers, instead of the previously produced Science and Technology Statement in the review of budget outcomes produced by DITAC.

Copies of this statement were circulated to NSTAG delegates, with a covering letter from the Science and Technology Minister, Simon Crean, in which he stated that overall Commonwealth support for ‘science and innovation’ had increased by 2.3% in real terms, compared to a decline of 0.6% in total budget outlays. He added that business spending on R & D had increased by 16% real from 1988-89, according to the Australian Bureau of Statistics. Table 7 of the S & T Budget Statement shows that on the most recent figures, Australia ranked 16th out of 19 OECD countries in total R & D expenditure as a percentage of GDP (although we rank 8th in government expenditure on R & D).

Structure

The issues identified for consideration by the conference organizers had been assigned to five working groups (or syndicates) drawn from industry, academia and government.

Each syndicate prepared a number of papers which were distributed to delegates before the Forum. At the Forum, each syndicate led a separate two-hour session at which its deliberations and recommendations were discussed. These were followed by a Summary Session, at which a joint working party attempted to condense the points made during the previous five sessions into a set of recommendations for endorsement by the delegates. The Forum was attended by over 150 people, of whom about 15% were from industry and the rest from academia, government research organisations and government departments. The attendance from industry was welcomed as an improvement on previous Forums and almost a third of the official speakers were from industry. This had the effect that the recommendations were perhaps slanted more towards the interests of industry than towards those of the scientific community, but most delegates seemed to accept this as a fair price to pay for the opportunity to get senior executives of some of Australia’s largest companies to concentrate on the need for science and technology for two days!

Opening Address

The opening speaker was Sir Eric Neal, Chairman of the Board of Westpac Bank, introduced by the President of I.E. Aust., Dr. Mike Sargent. Sir Eric set the tone of the Conference by arguing the need for Science and Technology (S and T) to contribute to the solution of Australia’s economic problems. He highlighted, as potential export earners for Australia, the areas of shipbuilding, banking (e.g. in software), adding value to commodities exports, tourism and education (overseas students!). He also endorsed privatization as a means of directing public resources away from areas such as airlines to infrastructure (road, rail, airports, ports, etc.)

SESSION 1: Setting the National Policy Agenda

Session 1 was chaired by Prof. Ian Ross (ANU Pro Vice Chancellor and AAS Science Policy Secretary). The speakers were Dr. Greg Tegart (ASTEC Secretary), Dr. John Stocker (CSIRO Chief Executive) and Prof. Ron Johnston (Director of the National Centre for Research Policy, University of Wollongong). Dr. Tegart argued that the Federal Government’s...
CONFEREE REPORT

1989 May Statement represented a watershed in science policy and suggested that the heckling of the Prime Minister by scientists at the opening of the National Science and Technology Centre had been the culmination of a series of expressions of frustration and added that "the message was heard!" He went on to chronicle the initiatives announced in the May Statement and subsequently, highlighting the Cooperative Research Centres Program. He presented a table, showing that, out of a total of $390.70 million promised in the May Statement for the five-year period 1989-94, the $39.00 million promised for the first year 1989-90 was exceeded by the $43.35 million actually allocated in the 1989-90 budget. The largest increase was in money spent on Commonwealth Postgraduate Awards. He concluded by describing the recent ARC and ASTEC proposal for a four yearly cycle of setting National Research Directions by means of a White Paper. The first White Paper is scheduled for tabling in May 1992.

Dr. Stocker outlined recent and planned developments in CSIRO and described its recently undertaken assessment of national priorities for research. Explicit criteria for assessment are:

- the potential benefits (economic, environmental and other social benefits)
- Australia's ability to capture the benefits;
- R & D potential, and
- R & D capacity.

The national research priorities were sub-divided into research purposes by CSIRO. Each research purpose was scored by the Chief Executive and Institute Directors in an iterative process involving consultation and discussion, and results have been displayed on a graph with coordinates for 'attractiveness' and 'feasibility'. The outcome of these corporate deliberations is to provide a framework guiding resource allocations. Dr. Stocker stated that the August 1990 Budget showed a marginal real increase in CSIRO's funding but the application of an efficiency dividend meant that unitled funds were reduced by $3.8 million. He also described CSIRO's award restructuring and stated that CSIRO divisions are dramatically improving their commercial capabilities. The changes in CSIRO were welcomed by the industry delegates at the Forum and the research assessment process was held up as a model by some of the later speakers.

Professor Johnston reviewed recent developments in Government science policy, under the headings of Concentration, Cooperation and Coordination. He also raised a number of important questions relating to these recent trends, including:

- how has the balance between long-term and short-term research shifted as a result of new policies?
- how may the 'managerialist' techniques of research management be introduced without damage to creativity?
- is the flow of science graduates adequate?

SESSION 2: The role of S & T in opportunities for greater returns from the products of Agriculture and Forestry

Session 2 was preceded by an introductory address by Mr. John Kerin, Minister for Primary Industries and Forestry. He emphasised the possible export gains to be achieved by increasing the downstream processing of Australia's primary products and the development of new technologies to counter the Greenhouse Effect. Similar themes were pursued by the speakers in Session 2.

SESSION 3: Minerals in abundance - Do they represent opportunities for greater returns?

The discussion in Session 3 was led by a large panel with representatives from Evans Deakin, BHP - Utah, Mount Isa Mines, Comalco, Ampol, as well as Sirotech and the University of Queensland. The industry representatives argued strongly that Australia's mining industry was a large and efficient export earner, in which private sector R & D heavily outweighed that funded by Government. Further questioning suggested, however, that the industry's claimed R & D allocation included the costs of mineral exploration. Most of the speakers concentrated on demands for government assistance in terms of access to resources, funding ('the government spends too much on small companies' and infrastructure. Although some speakers from the floor suggested that new CO emission...
CONFEERENCE REPORT

regulations could provide an incentive for R & D with export spin-offs, this issue was not taken up by the panel members.

SESSION 4: Creating wealth through manufacturing - the role of Government in developing an internationally competitive Design and Engineering capability in Australia

Session 4 was chaired by Dr. J.D. White, Chief Executive of AMECON, and involved panel members from industry, government, the Metal Workers Union, the Australian Academy of Design, and academia. The industrial representatives argued for government support of advanced manufacturing techniques and a national policy requiring that Australian engineers be involved in the design, engineering and project management stages of major Australian projects. Another speaker argued for government support for Australian manufacturing using the leverage of government purchases. The slogan 'support for proven performers' rather than 'picking winners' was endorsed.

SESSION 5: Human Resources in Wealth Creation

Session 5 was chaired by Dr. Angela Delves (Botany, ANU) and panel members included FASTS President, Prof. Tony Wicken as well as representatives of NBEET and the ACTU. Dr. Delves pointed out that Australia's research infrastructure was falling behind that of Europe. Prof. Wicken quoted the AIP figures on the shortfall in Australian Physics PhDs as well as the expected overall shortage of academics during the 1990's. Speakers from the floor argued that a 'strategic push' was needed to compete with the 'market pull' responsible for the greater attraction of law and business courses in comparison with science. CSIRO's plan for a 'Year of Science' in 1992 was mentioned and it was stated that each scientific discipline will be asked to explain what it contributes to the public good. One speaker pointed out that the current major political concerns with the Greenhouse Effect and the Ozone Hole were both dependent on basic scientific research. The issue of Australia's ratio of scientists to engineers was raised and reference was made to the controversial view of some members of the IEA Australia that Australia has enough scientists but needs more engineers.

SUMMARY SESSION

At the beginning of the summary session, each of the panels from the previous session produced a set of recommendations, redrafted in the light of the discussion which had taken place. These were combined by the joint working party into the following set of draft recommendations:

1. There is a need to decide on priorities for research. The CSIRO approach is useful and should be applied widely.
2. Australian productivity is low by world standards. R and D can have little impact until micro-economic reforms take effect.
3. There are many fertile fields. We need to make selections among them, such as:
   - Added value and further processing of minerals for substantial export growth
   - Adding value to primary production and processing
   - Mining equipment
   - Shipbuilding and offshore resource equipment
4. Success will depend on human resources. We need to:
   - Raise the image of Science and Technology as the solution to the problems of the future wealth and environment of Australia
   - Improve the quality and image of teachers at all levels (primary to tertiary)
   - Provide a selective focus on skills that make a substantial contribution to wealth and welfare
   - Provide increased recognition of the value of mathematics, science, technology and engineering skills programs
   - Improve management and other business skills.
5. There is a need for special research programs that will address and resolve environmental problems.

Each of the draft recommendations was then debated from the floor of the meeting. At times, the debate was fairly polarised between those who seemed to see industrial recovery as a precursor to more support for research, and those who saw additional emphasis on research and development as a pre-condition for industrial recovery. During the discussion, Recommendation 2 attracted strong opposition and was amended along the lines that R & D would not be fully effective until micro-economic reforms had taken effect.

CONCLUSION

The 1990 NSTAG Forum was rather disappointing to scientists attending for the first time, but some who had attended previous NSTAG Forums were more sanguine. They considered that the 1990 Forum inevitably bore the stamp of the Institution of Engineers who hosted it and of the current difficult economic climate. In this climate, it was probably a significant achievement to have gained substantial participation from industry, although unfortunate that the industry representatives were not more strongly convinced of the relevance of R & D to their current problems. A possible reason for this, which was barely discussed, was the predominance of foreign ownership in Australian industry. A different emphasis can be expected at the next NSTAG Forum hosted by FASTS.

R. O'Sullivan
AIP Science Policy Committee
Physics Enrolments in Australian Tertiary Educational Institutions
1980 - 1990

P.J. Jennings, Murdock University &
J.R. De Laeter, Curtin University of Technology


This survey contains information from all 33 institutions which have offered physics courses which are accepted by the Australian Institute of Physics. With the demise of the binary system and the subsequent restructuring of the tertiary educational system in 1989 there have been many changes of institutional names. The major changes are:

1. Queensland Institute of Technology has become the Queensland University of Technology.
2. New South Wales Institute of Technology has become the University of Technology, Sydney.
3. The Royal Military College and the RAAF Academy have merged to form the Australian Defence Force Academy in 1986.
5. Ballarat College of Advanced Education became Ballarat University College.
7. The Western Australian Institute of Technology became Curtin University of Technology in 1987.
8. The Northern Territory University began to offer physics in 1989.
9. The Royal Melbourne Institute of Technology has become the Victorian University of Technology.
10. The South Australian Institute of Technology has merged with part of the South Australian College of Advanced Education to form the University of South Australia.
11. The Canberra College of Advanced Education has become the University of Canberra.

12. Capricornia Institute of Advanced Education has become the University College of Central Queensland.
13. Darling Downs Institute of Advanced Education has become the University College of Southern Queensland.

Some changes have also been made to the presentation of the results of the survey. As a result of the demise of the binary system of tertiary education in Australia we have abandoned the distinction between institutions in the presentation of the data. We have also dropped the data on final year radiography enrolments.

All of the data were obtained directly from the Heads of the various Physics Departments. We have gone to great lengths to check the accuracy of the Tables. However, there may still be some minor inaccuracies due to the difficulty of uniquely identifying physics students at some institutions. The approach we have adopted is consistent with that used in all of the previous surveys. Therefore the results and trends should be comparable over the last 25 years.

Third Year Enrolments

Table I contains the data for third year physics enrolments for the period 1980-1990. Institutions are grouped by State. In Figure 1 we have plotted these enrolments over the twenty-three year period, from 1968 to 1990. A few of the numbers differ from those published in the previous surveys as a result of retrospective corrections notified by Departmental Heads during the course of this survey.

The third year enrolments continue to show modest growth since 1983. Enrolments towards the end of the decade have begun to return to levels reached in the mid-seventies after a substantial fall in the late seventies and early eighties. The trends are similar in all States.

The Australian results are similar to those from the USA where physics enrolments increased steadily through the late eighties after a decline in the late seventies (Ellis & Mulvey 1989)

These numbers also appear to be well-matched to vacant positions for physicists which have risen steadily in the late eighties (Prescott, 1990). Prescott concludes that employment prospects for pass graduates in physics are still attractive and that a choice of fields and institutions is available.
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<th>Table 1: Numbers of Third Year Physics Students</th>
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<td>University of Technology, Sydney</td>
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<td>University of Wollongong</td>
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<td>Royal Military College/ADF Academy</td>
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<td><strong>Total AUSTRALIAN CAPITAL TERRITORY</strong></td>
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* Physics major not available
It is also clear that several institutions still have quite small numbers in their final year classes. However, two of them have ceased offering physics and several others have merged. The current process of restructuring may lead to fewer institutions offering physics majors in the mid-nineties.

**Fourth Year Enrolments**

The data for fourth year enrolments from 1980 to 1990 are given in Table 2. The trends in enrolments from 1968 to 1990 are presented in Figure 2. The fourth year enrolments include honours, postgraduate diploma and masters preliminary students.

The fourth year enrolments have continued to grow, as noted in the previous survey. Over the decade from 1981 to 1990 the growth has been approximately 30% percent while third year numbers have grown by only about 15%.

Most of the growth at fourth year level appears to be due to enrolments in postgraduate diploma courses which provide an alternative for students not wishing to proceed to Honours.

At the present time it appears that the retention rate from third year to fourth year studies in physics is about 43%, up from 35% at the start of the decade. This reflects the increasing emphasis on higher qualifications noted by Prescott (1990).

Fourth year enrolments at many institutions are very small and several have discontinued their programmes. The recent report of the AVCC Academic Standards Panel in Physics found that honours enrolments were generally less than ten students per annum at all Australian Universities with the exception of the University of Melbourne (AVCC, 1990). Some institutions have augmented their fourth year enrolments by offering both honours and postgraduate diplomas in which students take some of the same units. linewidth
| TABLE 2: NUMBERS OF FOURTH YEAR PHYSICS STUDENTS  
HONOURS, GRADUATE DIPLOMA AND MASTER'S PRELIMINARY |
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*Australian & New Zealand Physicist* Volume 28, Number 5, May 1991
### TABLE 3: NUMBERS OF POSTGRADUATE PHYSICS STUDENTS

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Postgraduate Enrolments

The data on postgraduate enrolments is presented in Table 3 and Figure 3. It includes both Ph.D. and Masters students.

Over the past three years there has been a dramatic increase in postgraduate enrolments. For the decade 1981-1990 postgraduate enrolments have risen by more than 40%. This is a much greater rate of growth than for honours and pass degrees in physics.

Although the trend is similar in the USA the rate of growth in postgraduate enrolments in physics in Australia has been much greater. It appears to have been caused by increasing retention rates into honours and an influx of overseas students, especially in the last five years.

The growth is uneven with most of it occurring at the older Universities (Adelaide, Melbourne, Sydney, Queensland) and the Queensland University of Technology. The last can be attributed to a highly successful Masters by coursework degree in physics. Growth at the older Universities may be associated with increasing numbers of postgraduate students from Asian countries coming to Australia on IDP programmes.

It seems unlikely that this rapid rate of growth in enrolments can continue as resources at many institutions are stretched at present and funding for research in the physical sciences is not growing at a commensurate rate.

Tables 4 and 5 contain the actual numbers of Masters and Ph.D. graduates in Physics respectively.

Two institutions (Curtin University and the Queensland University of Technology) which have Masters by coursework programmes, produce approximately 50% of the Masters graduates in Australia.

The number of Ph.D. graduates has grown by approximately 40% over the past decade, similar to the trend in postgraduate enrolments. According to Prescott (1990) there were 250 positions advertised in 1989 for which a Ph.D. in physics or a related discipline was specified. The employment prospects for physics Ph.D.s are therefore very attractive and it is likely that many of the successful applicants are being recruited from overseas. If this shortfall is to be met from local sources the Commonwealth Government will need to put additional funding into physics research via the ARC and other research funding agencies.

Conclusions

At the end of the decade physics enrolments in third year, fourth year and postgraduate studies are growing. There has also been some restructuring of institutions and offerings which has improved the enrolment situation since 1987.

There are some uncertainties ahead, particularly the impact of Federal Government funding policies on research and student fees. Restructuring of the secondary education system in several States may also have an impact in the nineties.

Employment prospects for physics graduates have remained attractive, particularly for higher degree graduates. The shortage of Australian Ph.D.s for local positions may become critical in the mid-nineties as substantial numbers of academic staff members begin to retire. This has severe implications for academic standards and the national research effort. It is a problem which needs to be addressed urgently by the profession and the Government.

Acknowledgements

The authors are indebted to our colleagues in the various tertiary institutions who have kindly supplied us with the data and checked the Tables for us.

References

Australian Vice Chancellors Committee (1990), Report of the Academic Standards Panel in Physics.

Prescott, J.R. (1990), Aust. Phys. 27:183
**TABLE 4 : NUMBER OF MASTER’S GRADUATES**

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* The numbers represent those who actually graduate in each year.
### TABLE 5: NUMBERS OF PHD GRADUATES *

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* The numbers represent those who actually graduate in each year.

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**WAGGA 1992**

will be held **29-31 January 1992**
on **Pakatoa Island, New Zealand**
(travel to the island Tuesday 28 January evening)
The holiday resort island is situated near Auckland

Prof D. Beaglehole
For the Organising Committee
Physics Department
Victoria University of Wellington
PO Box 600, Wellington, New Zealand

*Australian & New Zealand Physicist* Volume 28, Number 5, May 1991
This meeting was held in Canberra last November in the Carlton Room of Otis’s Atrium Hotel in Canberra. The business, which was conducted with customary despatch by Professor Sandeman, included the election of the Branch Committee for 1991.

It comprises:

- Prof. R.J. Sandeman: Chairman
- Prof. A.R. Hyland: Vice Chairman
- Dr. K.G.H. Baldwin: Hon. Secretary
- Dr. N. Yazidjoglou: Hon. Treasurer

Committee

- Prof. P.J. Edwards
- Prof. N.H. Fletcher
- Dr. D.F. Hebbard
- Dr. S.P. Kravis
- Dr. L. Barbopoulos
- Ms. A. Fairhall
- Mr. F.W. Brown

The guest speaker on this occasion was

Prof. Lewis T. Chadderton, Chief Research Scientist at CSIRO and a Visiting Fellow at ANU. His address was not titled but might have been called,

Convictions, Strength and Courage.

He opened by noting the continual pressure on scientists in recent years, by the Commonwealth Government, to redirect Australian scientific research ever more exclusively into industry and technology. The scapegoat for this is the ‘economy’ which demands the creation of immediate solutions to specific problems yielding rapid financial returns and enhanced employment.

Maybe so, says Professor Chadderton, but it is a defeatist attitude which is born of the ‘wimp’ character of Australian scientists as a whole, so clearly identified by Barry Jones, which persuades our Federal politicians that we scientists are incapable of identifying the right way from the wrong. It is long overdue that we should reject the labelling of our research as ‘pure’, or ‘applied’ or owing a debt to society. The economic benefits of scientific research arise from advances in fundamental knowledge. The answers to particular applied problems can only follow.

High-speed electronic computers are with us now, rather than 100 years ago because we have learned a great deal about mathematics and solid state physics meanwhile. To-day’s enormous, global electronics industry rests on the fundamental research of J.J. Thomson, H.A. Lorentz and their colleagues. Professor Chadderton alluded to numerous similar examples of scientific developments which were preceded by the unrelated fundamental discoveries on which they were based.

The blazing fact is that economic benefits of scientific research are due to advances in fundamental knowledge. The applications follow. Most scientific research is an investment but fundamental research is more likely to yield benefits to society in general. It follows that this research should receive sustaining Government support as a national investment to increase fundamental knowledge. Of course it is obvious that fundamental and applied research may overlap or even proceed side by side. It is reasonable to expect that the applied aspect should be privately, industry supported, because the industry can see a profit at the end. But invest in basic research without privileged access to the results? In Australia it is difficult enough to have the first, rarely to find the second.

Professor Chadderton emphasised that Australian physicists must be more forthcoming and aggressive, using well-developed, convincing arguments, constantly repeated and targeted primarily at the parliamentarians who simply must change their attitude. ‘...a unique bond needs to be established between scientific society... and the body of Government... a new era of flexibility which does not force compromise on the excellence of our basic science, and the integrity of our scientists’. Australian scientists, not least we physicists, must have the strength of our convictions and the courage to carry them forward.

What is the mechanism for doing this? The answer, says Prof Chadderton, is Communication. We tend to shy from public contact. We avoid making the effort to present our work in understandable language. We fail to encourage dialogue and discussion of its worth and objectives with other than our scientific peers. We don’t try to promote our science as something everybody should like to see progress and flourish. It would be great if there was even one practicing scientist in the Australian Parliament. In the last one there were 54 teachers and lecturers - especially of economics - and 39 lawyers but only 4 engineers and not one scientist active in the field at the time he was elected.

However, politics is only one communication avenue. Wherever we go, there needs to be a quiet, firm and enthusiastic ‘sell’ of the undeniable value of fundamental physics research to society. It can be done by most research physicists, by choosing a specific target and bearing down on it.

Professor Chadderton alluded to his own exhilarating experience in addressing groups of school children. He recognises that many physicists, perhaps most, shrink from the idea of ‘selling’ physics. They may believe it is beneath their calling or declare, as did the author of a letter to the editor of The Australian, ‘Like the overwhelming majority of academics, I wish to be left alone so I can do what I conceive of as most important work there is, finding out how the universe works and inspiring others to do so too. ‘In black and white, his attitude seems less than inspiring! The survival instinct says we must defend the substance and integrity of the pursuit of fundamental research. The CSIRO initiative of their Project Ambassador is an example of what we must do throughout the Australian world of physics. In this context a supporting media group is great, providing it is an aid and not the main preoccupation.

Direct contacts with the public media are generally rewarding, if your contacts respect the rules of review. Professor Chadderton recalled an interview with an Age reporter in which he said, by way of an example that the beautiful TV ads of BHP and BP imply tremendous breadth and depth to our industrial research effort which, in his words, ‘is just not there’. The reporter’s translation was, ‘Senior CSIRO scientist says the best thing BHP does is its TV advertisements.’

Professor Chadderton summarised his address as identifying two central aspects of the life of a physicist:

- Developing anew a strength of conviction in what we are, what we do and in our value to society; and
- The courage to avoid being isolated as a profession; and the essential action, in some form or other:

COMMUNICATE!

F.W. Brown
The first meeting for 1991 was held on February 14 when Professor Alfred Seeger, the Director of the Max Planck Institut fur Metallforschung, Stuttgart and a professor at Stuttgart University, presented his talk entitled ‘Application of Nuclear Techniques to Condensed Matter Physics’. Professor Seeger began with a survey of the rapid increase in the importance of nuclear techniques to solid state physics since the second world war. This has coincided with the development of accelerators now capable of producing GeV muon beams. He emphasised the extreme importance of parity violation to methods which include polarized muon spin resonance, spin relaxation and spin rotation. Other methods briefly discussed included the instantanous doping of semiconductors and perturbed angular correlation (PAC).

A few of the techniques were then discussed in more detail. These included the high resolution probing of electric field gradients using pions and kaons known as time-differential perturbed angular correlation (TDPAC). This method can be used to detect crystal defects in samples. The technique known as pion or muon steering, where the particles are channelled through crystals, gives information about the presence of hydrogen in crystals. Muon spin resonance measurements provide information about the magnetic field distribution within a sample or alternatively the mobility or diffusivity of the muons. The trapping of positively charged particles by vacancies within crystals also provides information about the positions of these defects.

A.Roberts

Dr John Thomas has recently taken up the position of Professor and Head of the School of Applied Physics at the University of South Australia. He was previously Director of Research and Development with Brookhaven Instruments Corporation, New York. He has had extensive experience in academia and is enthusiastic about his challenging new position.

John is a recognised expert in the application of modern optical techniques to the study and characterisation of macromolecular and colloidal materials and has been active in basic and applied research in this field. He has been heavily involved in the commercial application of these techniques, particularly in the area of instrumentation for industrial particle size measurement. His research interests also include digital electronics and computer applications. At the University of South Australia John will establish a laser light scattering group whose main focus will be the application of laser and other optical techniques to materials characterisation and particle size measurement.

Previously John has been a Lecturer in Physics at the University of New England (1985-1987), visiting Assistant Professor in the Department of Chemistry at the University of Washington (1982-1984), Lecturer in Physics at the University of Waikato, New Zealand (1980-1982) and Postdoctoral Research Fellow in the Department of Chemistry at the University of Washington (1978-1980).

John graduated with a BSc. (Hons) in Physics from the University of Newcastle in 1975 and received a Ph.D. in Physics (Laser Light Scattering) from Macquarie University in 1979. He is a Fellow of the Australian Institute of Physics, a member of the American Institute of Physics and a member of the Institute of Electrical and Electronic Engineers.

During 1975-1978 he held a Commonwealth Postgraduate Research Award and in 1978 he was awarded a fellowship for a promising young Biophysicist by the 6th International Biophysics Congress, Kyoto, Japan.

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**Prof. Geoffrey Opat's Glossary for Quantum Mechanics (Hons)**

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<td>on a good day</td>
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Australian and New Zealand Physicist Volume 28, Number 5, May 1990 89
OF INTEREST

NOTE FOR USERS OF RADIOACTIVE MATERIAL

Transport Of Radioactive Material By Road

New Ministry of Transport requirements relating to road transport of hazardous materials became effective on 1 January 1991. The requirements of New Zealand Standard NZS 5433:1988 (as amended) are now mandatory. This is causing some problems for people wanting to transport radioactive materials.

Section 3.2.7.2 of NZS 5433:1988, relating to radioactive materials, states:

'All conditions of packaging, labelling and transporting are controlled in New Zealand by the Radiation Protection Regulations 1982.'

There has been no change in any requirement under Regulation 3 of these Regulations. Any transport operators requiring confirmation of this should be asked to phone the National Radiation Laboratory, (03) 663-039.

For any road transport of radioactive material following, or prior to, air freight, the IATA, 'Shippers' Declaration for Dangerous Goods' form is acceptable. For transport by road alone, the former 'Dangerous Goods Declaration' form (G27) is no longer valid. The 'New Zealand Hazardous Substances Dangerous Goods Declaration' form specified by NZS 5433:1988 is not appropriate for radioactive materials. Copies of an alternative form for radioactive materials are available from the National Radiation Laboratory on request.

WANTED

Interesting transparencies or good colour photographs to be used for the Physicist front cover.

Please send submissions together with a descriptive caption to:

Production Manager
Australian & New Zealand Physicist
Impress Studios
44 Kemp Street
The Junction NSW 2299

TWELFTH INTERNATIONAL WORKSHOP ON

Rare-Earth Magnets
And Their Applications
July 12-15, 1992

SEVENTH INTERNATIONAL SYMPOSIUM ON

Magnetic Anisotropy and Coercivity in Rare-Earth Transition Metal Alloys
July 16, 1992

Preliminary Notice

The Twelfth International Workshop on Rare-Earth Magnets and their Applications is to be held at the Lakeside Hotel in Canberra in 1991. This will be a continuation of the series workshops and symposia which have provided opportunities for effective exchange of current information and ideas on the development and utilization of rare-earth magnets (such as circuit design, device and system engineering, manufacturing), evaluation and standardisation of test methods and instrumentation. The workshop (12-15th July) will consist of three days of plenary and poster sessions and opportunities will be available for exhibits of industrial products, devices materials and test equipment. The symposium will be held on the 16th July. Copies of the workshop and symposium proceedings will be available to participants on registration.

The nominated International Carrier for the conference is Qantas Airways. The conference is to be organised in collaboration with Australian Convention and Travel Services Pty Ltd (ACTS) and is sponsored through the Department of Industry Technology and Commerce by the New Materials Technology Committee of the Industry Research and Development Board.

Correspondence with the Organising Committee may be directed to:

Robert Street
Department of Physics
University of Western Australia
Nedlands WA 6009

Australia
Phone: (09) 380 1014
Fax: (09) 380 1014
Electronic Mail: remxii@carwax.uwa.oz

John Cook
CSIRO Division of Applied Physics
PO Box 218
Lindfield NSW 2070

Australia
Phone: (02) 413 7531
Fax: (02) 413 7383
Electronic Mail: remxii@dap.csiro.au

or for further information contact:

ACTS
GPO Box 2200
Canberra ACT 2601 Australia
Phone: (06) 257 3299
Fax: (06) 257 3256
International Fax (616) 257 3256

Australian & New Zealand Physicist Volume 28, Number 5, May 1991
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- May be required to spend some 'summers' at the ANARE (Australian National Antarctic Research Expeditions) stations in association with the deployment, calibration and operation of equipment.

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**CONTACT OFFICER:** Dr Gary Burns (002) 323315.

Applicants are urged to obtain copies of the official Duty Statements and Selection Criteria and to frame their applications accordingly. These may be obtained by telephoning the Recruitment Officer on (002) 323402.

Applications are to be received by the Antarctic Division no later than COB May 24 1991 and should be addressed to:

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**OF INTEREST**

**Fibre Optics in Astronomy II**
**Sunday 10th - Thursday 14th November, 1991**
**Power House Museum**

**ANNOUNCEMENT**

As a follow-up to the 1988 Tuscon conference, the Anglo-Australian Observatory plans to hold a four day conference on the use of fibre optics in astronomical instrumentation.

**Topics to be covered include:**
- Fibre properties and testing related to astronomical applications
- Fibre feeds to remote instrumentation /Infrared fibres and instrumentation
- New techniques and future applications/Multi-object fibre instrumentation

**Venue:** Power House Museum, Sydney

**Accommodation:** Available close to the conference venue.

**Programme:** Both oral and poster contributions plus a number of invited papers.

**Proceedings:** To be published from papers submitted at the Conference in camera-ready format.

**Tour to Siding Spring Observatory:** If there is sufficient interest, a visit to the Anglo-Australian Telescope and the UK Schmidt Telescope at Siding Spring will be organised for Thursday 14th to Saturday 16th November.

Further information: Peter Gray or Sandra Harrison, Anglo-Australian Observatory, PO Box 296, Epping NSW 2121 Australia
Ph: 61 2 686 1666, Fax: 61 2 876 8536.

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**OBITUARY**

**Professor Daphne Jackson OBE**
F.Inst.P., CPhys, FSEE, CEng, MIEEE

Professor Jackson died on February 8th after a two month illness. She had previously battled against cancer for ten years, although throughout that time she had remained very active and continued to fulfill her duties as Head of the Department of Physics at the University of Surrey.

An internationally respected nuclear theorist, Professor Jackson was appointed lecturer at Surrey in 1960 (at the age of twenty four) and Head of Department in 1971. During her career she was awarded a D.Sc. by the University of London (1970), honorary doctorates by the Open University (1987) and the University of Exeter (1988) and an OBE in 1987.

In the latter part of her career, Professor Jackson’s main research interest was medical physics. She believed passionately in the importance of the role of physicists could play in medicine and fought to increase the status of, and funding to, the very small number of physicists in that field in the UK. During her visit to the University of Adelaide in September 1988, she lectured on the ‘Applications of Physics to Medicine and Biology’ and commented publicly on the minimal effort in this field in our country.

As well as being a successful physicist, Professor Jackson was also a woman in a field where women are still a small minority. Her role as a model for other women and girls was one that she took very seriously indeed. Much of her last ten years was devoted to encouraging women into science and engineering and to raising funds to ease their entry. She personally established the ‘Fellowship Scheme for Women Returners to Science and Engineering’ in the UK. Her discussion of that scheme and its successes during a talk on 'Women in Science and Engineering' at the City Campus of SACE in 1989, led to the establishment of a (much smaller) scholarship scheme for women returning to academic life at the University of Adelaide. When asked directly, at that meeting, how physics could be changed to encourage more participation by women, she was very blunt. She clearly stated that it was not physics that must change but society’s attitudes as to what was proper for a girl to study at school. In her view there needed to be positive incentives for girls to study real mathematics and science, not a watering down of the courses offered to girls.

Daphne Jackson was an outstanding scientist and an inspirational human being. Her achievements will be appreciated for a very long time.

A.W. Thomas FAA
Elder Professor of Physics
Smart Precision Time Delay Generator

TARDIS II programmable delay pulse generator has been developed to meet the needs of modern laser research laboratories. With a choice of eight or ten delay channels, each with multiple configurable o/p, and timing jitter less than 1nS, the TARDIS II forms the heart of a multiple pulsed laser spectroscopy system.

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Frequency doubling accessories to cover the 345nm to 460nm range will be released shortly. For more information on the TS60, or for details of suitable Nd:YAG pump lasers, please contact Coherent Scientific.

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Stanford Research Systems’ new model DS345 Synthesised Function Generator offers the advantages of digital waveform synthesis for the price of a conventional analog instrument.

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Coherent U.S. has announced the release of the new "Innova-400" range of high power argon-ion and krypton-ion lasers. The Innova-400 is a development from the very successful Innova-200 series of "large frame" lasers. Key improvements have been in the areas of active stabilisation, and output power.

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PRODUCT NEWS

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Australian Journal of Physics

Contents

| Volume 44 | Numbers 2 & 3 | 1991 |

QUANTUM STRUCTURES

A collection of essays in honour of Professor Ian Ellery McCarthy on his sixtieth birthday

Foreword. Erich Weigold and Reg Cahill 101

On the Importance of Self-Interaction in QCD. R. T. Cahill 105

Models for fermion generations based on five fermionic coordinates. R. Delbourgo, P. D. Jarvis and R. C. Warner 135

Relativistic bound states. B. H. J. McKellar 149

Soliton matter. L. R. Dodd 161

Chiral corrections for lattice QCD. Anthony W. Thomas 173

Composite mesons in self-confining chiral solitons. P. C. Tandy and M. R. Frank 181

Resonances in few-body systems. I. R. Afnan 201

Inelastic scattering from 20Ne. K. Amos, L. Berge, C. Steward and R. de Swiniarski 217

The quantum mechanical inverse scattering problem at fixed energy and some recent applications. L. J. Allen 231


Electron scattering from copper. P. J. O. Reubner 259

Positron impact ionisation of H and He atoms: The continuum model. K. Ratnavelu 265

Model investigation of a soft X-ray photoionisation laser. A. M. Weigold 271

The development of electron momentum spectroscopy. Erich Weigold 277

How to explain the difference between (y,e) and (e,2e) spectroscopic factors. M. Ya. Amusia and A. S. Kheifets 293

Nonlinear susceptibilities of conjugated organic systems: Fused-ring oligomers. C. R. J. Williams 299

Structure of quantum fluids at nonzero temperature. R. G. Storer 305

Experimental study of quantum structures in solids. Kaare J. Nygaard 315

Quantum mechanics, real and artificial intelligence. H. S. Green and T. Triffet 323

Australian & New Zealand Physicist Volume 28, Number 5, May 1991

95
Prompt Critical

Easy-to-Swallow Scientific Vitamin Supplement

George Gamow's Mr. Tompkins was one of the better attempts to present an important scientific idea to the masses. And, better still, he helped turn on young people to science. Goodness knows we have in this country a desperate need for those rare persons who can achieve both of these things. The various science programs on the ABC are generally very good (with a few lapses, such as the recent Sellafied TV beat-up), however the ABC's real strength lies with a few individuals such as Rob Williams and the JJJ prize-winning Dr. Karl Kuszelnicki. Karl has now collected some of his most interesting scripts into an ABC book titled 'Latest Great Moments in Science'.

It is a book for all ages. Few of us will not learn something new from its thirty nine scientifically diverse episodes. Indeed, I have been pleasantly irradiated by lots of new facts and ideas while reading it from cover to cover. Furthermore, each episode is appended by several source references to allow checks and encourage further reading. Unfortunately Karl has not tied each reference to the corresponding text as closely as I would like. Some of the references to Nature or Scientific American will be fairly readily available, but some sources like Science Digest or Discover will be hard to locate, especially for back issues more than a couple of years old, as most are.

Notwithstanding what I have just said, there are quite a number of assertions for which I doubt reference support, such as the claim on page 14 that 'four of every five physicists work for the military on projects like these', referring to uranium and reactive tank armour. Also a modicum of healthy scepticism is called for in places, such as Meaden's explanation of crop circles (even though the source is the Journal of Meteorology). And Karl's Big Bang cosmological sequence is faulty, despite his degrees in physics and mathematics. Last, but not least, I can personally assure Karl that his assertion is quite wrong that scientists have no explanation for 'strange snapping, hissing, clicking or crackling noises' occasionally heard to accompany a lightning stroke.

As a final, personal, impression I must say that I found the illustrations quite unattractive, with a triviality that undermines the positive thrust of the science being presented. Maybe they make the book attractive to very young people. Not being so young any more, I cannot say. However I would have liked, for example, a picture of the amazing hoatzin bird rather than the anatomically distorted sketch of a cow's digestive system.

But don't let what I have just said deter you from purchasing such a delightful book for yourself or your family. It is available in paperback for A$16.95 from any ABC Bookstore or bookshops that stock Allen & Unwin titles.

Colin Key
Book Reviews Editor

Reviews

Elementary Particle Physics

0. Nachtmann
Springer-Verlag, Berlin, 1990
xx + 599pp, $69.75 (softcover)

The so-called 'standard model' of elementary particles and their interactions, based upon the Glashow-Salam-Weinberg spontaneously broken SU (2) x U (1) gauge theory of electromagnetic and weak interactions (quantum chromodynamics) and the SU(3) colour gauge theory of the strong interaction (quantum chromodynamics) has been spectacularly confirmed by numerous experiments over recent years and provides a systematic and economical account of nearly all elementary particle phenomenology. No appreciation of current or proposed experiments in particle physics, or of theoretical developments such as grand unified theories, supersymmetry or superstrings is possible without a comprehensive knowledge of the standard model and, as the essential aspects of this model are now well established, there are compelling reasons for including a course on the standard model in all Physics Honours programs at Australian universities. However, if these lectures are to be accessible to students other than aspiring particle theorists, the presentation of the standard model must not be too heavily based on the highly technical quantum theory of non-Abelian gauge fields.

Otto Nachtmann is to be congratulated in providing an extremely comprehensive account of contemporary particle physics within the interpretative framework of the standard model using a minimal foundation of quantum field theory. The emphasis is on the physical principles behind elementary particle interactions and on how to calculate these processes using the Feynman rules as a 'prescription'. Detailed calculations are provided for several basic processes and the author has included numerous exercises, together with some partial solutions, to encourage the student to develop these calculational skills.

Elementary Particle Physics is carefully written, attractively typeset, well illustrated with diagrams of experimental data and remarkably free of typographical errors. I have only a few minor criticisms. Faddev-Popov ghosts are included in the Feynman rules without any explanation (I), an expanded section on renormalisation is needed if the student is to appreciate the role of renormalisation in high precision experimental tests of the standard model and some discussion of the renormalisation group should be included to clarify the very brief statements on running coupling constants. Although Elementary Particle Physics describes the state of particle physics as of 1988, prior to the advent of Z physics at the SLC and LEP e^+e^- colliders, I feel Nachtmann should have provided a more detailed treatment of the production and decay of Z bosons in e^+e^- collisions as these topics are of great current interest. In summary, I highly recommend this book as a text for Physics Honours courses in particle physics.

Ian Whittingham
Physics Department
James Cook University

Selected Papers Volume 5
Relativistic Astrophysics

S.Chandrasekhar
University of Chicago Press, Chicago 1990
xx+587pp, US$29.95 (paper)

Volume 5 of the Selected Papers of S.Chandrasekhar contains a total of 34 technical works on relativistic instabilities, post-Newtonian approximations, and the stability and equilibrium of rotating systems in general relativity. It also contains 7>
miscellaneous papers on general relativity in astronomy, and Dirac's views on the aesthetic basis of Einstein's formulation. Extensive though they be, these selected papers do not cover all of Chandrasekhar's contributions to the general theory of relativity, and in his foreword, K.S.Thorne anticipates the appearance of Volume 6, covering black holes and colliding gravitational waves.

The technical papers exhibit the compact, tight style so characteristic of Chandrasekhar, and many consist of pages and pages of long algebraic results punctuated by brief explanations and arguments. This is clearly for specialists! However, there are several shorter papers which may be regarded as 'tutorials' on the major works, or which summarize the mathematical results and place them in a broader context. These provide a way for the non-specialist to develop an appreciation of the research program being followed in this field.

The papers in the 'Miscellaneous' section are definitely for the non-specialist, and contain some of the clearest expositions of the foundations of Newtonian and relativistic mechanics I have read. They would well form the basis for essays by senior undergraduates in physics, mathematics, and several should certainly appear on reading lists for advanced courses in general relativity or cosmology. Volume 5 also contains a compact but thorough Foreword by K.S.Thorne, which paints the backdrop for the papers in this selection. This Foreword is nicely complemented by the recent review of experimental tests of the general theory presented by C.M.Will in Science (Vol 250, pp770-776, 1990).

It is unusual for scientists' papers to be collected together as has been done in these volumes. But Chandrasekhar's work is so cohesive, and so close to the central development of the subject, that the enterprise is justified and successful. Students and researchers alike will enjoy and benefit from the availability of the corpus in a single set of volumes.

L.E.Cram
School of Physics
University of Sydney

Resonant Heterogeneous Processes in a Laser Field
V.A.Kravchenko, A.N.Orlov, Yu.V.Petrov and A.M.Prokhorov

Despite the rather abstruse title, this is an interesting book in the USSR Academy of Sciences series which deals with the application of lasers to the separation of multicomponent mixtures using surfaces and membranes. As is typical of this series, the use of direct translations rather than lucid phraseology makes for a degree of incomprehensibility which extends to the title.

This aside, the book aims to systematize a subject which has previously been the classified domain of people involved in making 'weapons'. This enrichment of fissile materials aspect of the technology receives a one-sentence mention, and a glance at the references shows two Russian works on this topic amongst what is predominantly a Soviet bibliography.

The book's primary concern is with the resonant interaction of laser light with molecules, in particular with evanescent field of a laser near the surface of dielectric media. It is the resultant polarization and the excitation energetics that influence the interaction of the molecule with the surface and with other molecules near the surface. The selectivity of the resonant process can therefore be used to separate particular species in this manner.

After dealing with these surface effects, a number of membrane structures are considered: pores, whose dimensions are less than the wavelength of the light; capillaries, filled with radiation from the surface; and tubes, with laser light passing only along the axis. It is pores of diameter larger than most molecular dimensions but with strong resonant interactions with the surface that are shown to hold most promise for high efficiency separation, especially compared to conventional molecular dimension membrane techniques.

The book contains a comprehensive theoretical treatment of the subject, and also deals with (to the predominantly Soviet) experimental literature. It is a book for the specialist, but gives a good insight into the newly developed technology.

Kenneth G.H. Baldwin
Laser Physics Centre
Australian National University

Conformal Invariance and String Theory
Petra Dia & Vladimir Georgescu (Eds)
Academic Press, San Diego CA 1990 xiv+557 pp., US$59.95 (hardcover)

This tome has been a familiar resident on my desk, awaiting review, for some time now. My original impression was of a relatively bland conference proceedings from a small Romanian meeting. Something of its essence must, however, have been transmitted by its mere presence, and by my idly glancing through it. I now find that it, in fact, contains a surprisingly well-balanced set of papers on each of the (inter-related) topics mentioned in the title.

For example, the contributions on conformal invariance deal with operator and current algebra aspects (Todorov and Plame). The classification of modular invariants (Salez and de Francesco) as well as the connections with numerical studies of 2D critical models (Rittenberg), and with integrable systems (Korowski), although the latter does not include the more recent work on quantum groups. Developments in string theory are covered in papers on concrete constructions by Ninis, (orbifolds models), Lerche and Schellekens (four-dimensional lattice models), and Kerner (generalized Kaluza-Klein theories). The formal mathematics of quantization of closed strings and the Liouville model are dealt with by Paycha.

Features of the book are a comprehensive (100 page) introduction to (infinitesimal) determinants by Cartier, and 'Reflections on Arithmetic Physics' by Yuval Manin, which may be one of the first airings on p-adic numbers as a possible underpinning of some features of string theory.

This is a usuable book for theoretical physics library shelves. As to the meaning of the whole endeavour, Manin quotes Grothendieck with approval: "Il en est qui se contentent de ... parier qu'il n'y a rien a tirer de tout cela, sauf des rêves..."

Peter Jarvis
Department of Physics
University of Tasmania

Advances in Magnetic Resonance Vol.14
The Waugh Symposium
W.S.Warren (Ed)
Academic Press, San Diego CA 1990 xiv+296 pp., AS$164.60 (hardcover)

Volume 14 of 'Advances in Magnetic Resonance' is a collection of half of the papers presented at the Symposium on 'High Resolution NMR in Solids' in honour of John Waugh and held from January 19 to 21 at the Massachusetts Institute of Technology. The other >
symposium papers have appeared in volume 13 of this publication series and consisted of articles dealing with well established techniques. Volume 14 concentrates on theoretical and experimental techniques which have not yet been widely used and therefore, despite the delay in publication, contains a wealth of useful material for researchers using high resolution NMR in solids.

The theory presented is straightforward for anyone familiar with density matrix methods, Clebsch-Gordan coefficients, correlation theory and the Wigner-Eckart theorem but is heavy going for those without such a background. All but one of the articles present experimental data for comparison with and testing the equations derived. Several pulse sequences are described in detail with experimental results that clearly show the improvements in high resolution NMR spectra of solids that have been achieved. All of the articles are well written and present new results so that they are not simply review papers.

John Waugh began the work that has led to the above development of high resolution NMR of solids and so it is fitting that this symposium should have been held in his honour. It will be very interesting to follow the application of the results presented in this book to biophysics and medical diagnosis.

Overpriced at SA164, together with Volume 13, it costs about SA320 for the complete 1989 symposium proceedings. However, it is a useful book to have in the library.

P. Szekeres
Department of Physics
Mathematical Physics
University of Adelaide

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**Functional Analysis : An Introduction for Physicists**

Nino Boccara
Academic Press, San Diego CA 1990
xiii+327 pp., AS$97.65 (hardcover)

The worst thing about this book is its title, which is essentially a case of false advertising. Theoretical physicists today are all aware that they should know something about functional analysis - Hilbert spaces and distribution theory in particular. They might reasonably be led to believe then that here is a book which would introduce them to an understanding of how this field bears on physics.

Now here is the rude shock. The only place I could find where physicists are even mentioned is in an example involving a rather exotic function called the Devil's staircase. It is claimed that this function has recently been rediscovered by physicists, but no statement is made as to what the physical context might be. Throughout the entire book there is not one mention of quantum mechanics, anywhere. It is true that the heat equation appears a few times by way of simple examples, and there are a couple of pages on charges treated as distributions in classical electrodynamics, but these hardly merit a busy physicist wading right through this detailed text.

In the foreword we read that the author proposes to 'break away from the definition-theorem-proof style of exposition'. This sounds pretty promising to a physicist hoping to get the basic mathematical ideas in a more expository, informal way. However on the top of page 2 we find:

Definition 1. A class A of subsets of a set X is said to be an A-algebra (sigma algebra) if (three conditions follow). This is followed by Theorem 1, Definitions 2 and 3, Theorem 2 and a Lemma. By page 3 we are up to Definition 4 and Corollary 2. Now if this is not a definition-theorem-proof style, I would hate to contemplate what the author envisages for a truly formal presentation.

Having aired my big gripes about this book, let me conclude by saying that this is really a quite excellent (mathematical) text on functional analysis. The definitions and proofs, with few exceptions, are clear and to the point and range of topics is good. It is nice to see examples from chaos theory and fractals brought in, and the really big bonus of this book is the very large number of worked examples and problems (all with solution). But it is no textbook for physicists unless, like me, their training is basically mathematical and they know most of this stuff anyway.

Ken Doolan
Department of Physics
University of Western Sydney
Macarthur
**BOOK REVIEWS**

**Journey to the Ends of the Universe**
C.R. Kitchin
Adam Hilger, Bristol 1990
ix+198 pp., UK£14.95 (hardcover)

Should you ever decide to descend a black hole, then Chris Kitchin’s latest book is required reading. In the process of providing a guided tour of the Cosmos, the author provides detailed accounts of supernovae, planetary nebulae, black holes and cosmic strings.

It is no mean feat to cover such a wide range of topics in a theoretical way while maintaining the reader’s undivided attention. Chris Kitchin has succeeded in producing one of the more readable accounts of the theorician’s universe.

Each chapter is a self-contained essay written in an entertaining and undemanding style, pitched at about the level of General Studies undergraduates. The first chapter is, unexpectedly, an account of the Big Bang and subsequent evolution of the Universe. Perhaps one of the most difficult concepts the reader can encounter, the development of the theme is clear and introduces some useful analogies for cosmic strings.

If there are any complaints, it is that the prints and diagrams fail to do justice to the text. Illustrations of quasars and other astronomical objects are of very poor quality. An unusual feature of the book is the use of crude diagrams showing the relationship between the visible constellations and radio and infrared sources discussed in the text. These are clearly not visible to any but those with access to the largest telescopes.

‘Journey to the Ends of the Universe’ is the sort of book which stimulates conversation over coffee, gets handed around between undergraduate and postgraduate students and is required reading for any academic who wants to stay one jump ahead of their students.

This book held me spellbound, providing insights into novel ways of enlivening cosmology lectures. I recommend it to libraries, educators, students and the public.

G.E. Stedman
Physics Department
University of Canterbury

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**Plasma Deposition, Treatment and Etching of Polymers**
R.D’Agostino, (Ed)
Academic Press, San Diego CA 1990
xiii+528 pp., US$95.00 (hardcover)

This is the fourth volume of the series Plasma-Material Interaction coming after two volumes on Plasma Diagnostics and one on Plasma Etching. In all volumes, the chapters are written by known experts in the field, the style is understandable for non-experts and the bibliography immense. This volume concentrates on polymers and includes an introduction to plasma polymerization of fluorocarbons, organosilicones, organometallics, metal-plasma composite films, etching of organic polymers, application of plasma polymers and plasma treatment for biomaterials.

This is a translation from a 1976 Japanese edition. It comprises an introduction to group theory, in which the basic concepts are introduced gently and developed succintly, and an overview is given of a wide variety of applications in various practical situations in solid state physics. Clear signposts guide the reader who wishes to address a particular topic.

This coverage is obtained at a severe price; few topics are given justice, and the treatment is often fragmentary, for example the conjugation symmetries of the spherical tensor operators. In addition, this book was published in the mid-1960’s, it would have been out of date. The references are few and ancient - a 1943 paper by Wilson (not the famous book) for molecular vibrations; Griffith’s 1961 book on Clebsch-Gordan coefficients; Racah (1949) on the symmetric group.

Neither references nor text appear to be cognisant of the subsequent advances, many of them major. Even the parts (ladder fields, infrared and Raman scattering, Landau theory of phase transitions) where the authors’ and editors’ interests are obvious, are equally terse and dated.

I could not recommend this book. There are many better accounts.

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**Diagram Techniques in Group Theory**
Goeffrey E. Stedman,
Cambridge University Press 1990
xiii+308 pp., AS$165.00 (hardcover)

If you enjoy doodling and have a good working knowledge of group theory and related subjects, this book is just what you’ve been waiting for. The author makes a valiant attempt at transcribing all the various formulae/manipulations from several fields of mathematical physics into a diagrammatic notation. The activity is not unheard of; it has been used in field theory for a long time, following Feynman’s seminal work, and has found some aficionados in applications of the rotation group through the methods of Jacys, Levinson and Vanagas. Stedman takes the idea all the way, developing rules with associated comments and helpful problems as he proceeds.

However, I remain unconvinced that the diagrammatic route is always best. Some of the graphic rules/
interpretations are incredibly convoluted (and therefore look forced) when trying to reshape algebra into geometry; you have only to look at typical pages 66 and 67 to realize that in many instances the time-honoured algebraic is much more compact and elegant than the pictorial way. In some cases the rules change as one goes along, with Stedman recognizing the limitations of his earlier development. My impression is that the second edition of this text will probably contain the definitive version of the picture book rules, since they are not completely settled in this edition.

I enjoyed his writing style and was taken by his last paragraph which I will quote verbatim, since it concerns an error in QED that the author helped to detect via diagrammatic reasoning:

"We close with this little cautionary tale and historical curiosity. Feynman kindly commented in a letter to the author: "It is unusual to find an error in a (Klein-Nishina) formula that has been around for so long, and in so many books, and done by so many people as an exercise." The concluding moral is obvious. The new research student in the admittedly fearsome world of theoretical physics should not allow himself or herself to be brainwashed by an apparently overwhelming burden of personal ignorance. One should take heart and check everything."

I shall repeat it to my students in case their work disagrees with standard lore.

In summary this book was not for me, but it may well be for you. However I wonder why it costs so much. Does $65 reflect the cost of producing all those figures???

R.Delbourgo
Physics Department
University of Tasmania

New Books

Liquid Phase Epitaxial Growth
M.G. Ashles
Adam Hilger (IOP Publ.), Bristol 1990.
ix + 221 pp. UKE 45 (hardcover)

Creative Understanding: Philosophical Reflections on Physics
R. Torretti, University of Chicago Press, Chicago IL 1990
xvi + 369 pp. US$ 32.50 (paperback)

The Conscious Universe
M. Kafatos and R. Nadeau
Springer-Verlag, Berlin 1990
xii + 214 pp. PM 49.80 (paperback)

The Relative Biological Effectiveness of Radiations of Different Quality.
National Council on Radiation Protection, Report No. 104
NRC, Bethesda Md 1990
viii + 218 pp., US$ 18 (paperback)

Laser Ultrasonics
C.B. Scruby and L.E. Drain
Adam Hilger (IOP Publ.), Bristol 1990.
xii + 447 pp. UK£ 50 (hardcover)

Exercises in Practical Astronomy
using Photographs
M.T. Bruck Adam Hilger (IOP Publ.), Bristol 1990.
ix + 108 pp. UK£18.50 (hardcover)

Molecular and Biological Physics of Living Systems, R. K. Mishra (Ed.)
x + 298 pp., DM 160 (hardcover)

Strained-Layer Super-Lattices
Materials Science and Technology
T.P. Pearsall (Ed.)
x + 421 pp. US$89.50 (hardcover)

Theory of Simple Liquids (2nd Edition)
xi + 556 pp. UK £ 24.50 (paperback)

The Science Achievement of Year 12 Students in Australia
M.J. Rosier and M.G. Long
xxiii + 198 pp., no price given (paperback)

Collected Papers Vol.6: The Mathematical Theory of Black Holes
and of Colliding Plane Waves
xix + 739 pp. US$35 (paperback)

Earthwatch: The Climate from Space
J.E.Harries
Ellis Horwood, Chichester UK 1990
216 pp. AS 42.50 (hardcover)

Introduction to Magnetism and Magnetic Materials
D.Jiles
xx + 440 pp. AS$134.95 (hardcover) or AS$67.95 (paperback)

Electroweak Interactions
P.Renton
Cambridge University Press, Cambridge UK 1990
xxii + 596 pp. A$ 85 (paperback)

Data Analysis Techniques for High Energy Experiments
M.Regler (Ed)
Cambridge University Press, Cambridge UK 1990
xiv + 434 pp. A$ 205 (hardcover)

A Reviewer's Correction:
'The remarks made by me on page 48 (ANZP, Vol. 28, No. 3) about resistance being proportional to $\rho_x$ (the square root of the Hall coefficient) in Bi-based superconducting oxide films were based on a careless examination of the paper by S.Miyazawa et al. I must have been thinking that a plot in their paper involving these quantities for a particular film was connected with a plot of the derivative of the resistivity with respect to temperature against the square root of the Hall coefficient for a variety of films. Also, I did not notice that, although the plot was linear, extrapolation of the linear plot gave a negative intercept on the resistance axis. Contrary to my statement in the review, there is no obvious connection between the results shown in the plot and the requirements of a two-band model I have used to explain the temperature dependence of Hall coefficients in another of the high-temperature superconducting oxides.'

D.M.Eagles
Institute of Electronic Structure and Laser, Heraklion, 71110, Crete, Greece
CONFERENCES & MEETINGS

1991

June 5
Symposium on Propagation Effects in Communications, Sydney
To be held in conjunction with AUSSAT, CSIRO, OTC
and Telecom Research Laboratories
Dr Bruce MacA. Thomas or Carol D. Wilson
CSIRO Division of Radiophysics, Marsfield NSW
Tel: (02) 868 0264, Fax: (02) 868 0450

July 1 - 5
Gordon Godfrey Workshop on Strongly Correlated Electron Systems
Dr. D. Neilson, Physics, UNSW, Kensington NSW 2033
Tel: (02) 697 4564

July 15 - 19
Introduction to Optical Design Course
Continuing Education Office, Macquarie University, Tel: (02) 805 7470

July 23 - 24
Asian Physics Education Network - 200 Years Faraday's Birthday Meeting
Registration: Professor Geoffrey I. Opas, School of Physics,
The University of Melbourne, Parkville VIC 3052
Tel: (03) 344 5121, Fax: (03) 347 4783

August 7 - 16
PIXAM X-Ray and Surface Analysis Conference, Hawaii (including workshops)
Pixam c/o AXAA, PO Box 90, Parkville VIC 3052
Tel: Don Williams (03) 337 7211 or Brian O'Connor (03) 351 7192 or
Julius Bogl (02) 218 9530

Sept 27 - 30
1991 Annual Meeting of The Physical Society of Japan
Hokkaido University, Sapporo-shi, Hokkaido
Enquiries: The Physical Society of Japan, Room 211, Kikai-Shinko Building,
3-5-8 Shiba-Koen, Minato-Ku, Tokyo 105, Japan
Tel: (03) 3434 2671

Sep 29 - Oct 4
Australian Conference on Optics, Lasers & Spectroscopy – ACOLS '91
Australian National University, G.P.O. Box 4, Canberra ACT 2601
Tel: 61-6-249 4244, Fax: 61-6-249 0029

Sep 30 - Oct 4
International Conference on Ion Sources (ICIS '91), Bensheim, W. Germany
B. Wolf; GSI, Postfach 110552, 6100 Darmstadt, W. Germany
Tel: 49-6151-359 320, Fax: 49-6151-359 785

Oct 1 - 3
ANZAAS Congress 1991 - 'Reproduction and Renewal'
c/o Prof. David Boyd, The University of Adelaide,
PO Box 498, Adelaide, SA, 5001
Tel: (08) 228 5843, Fax: (08) 223 7650

Nov 10 - 14
Anglo-Australian Observatory - 'Fibre Optics in Astronomy II'
Power House Museum, Sydney
Peter Gray or Sandra Harrison, Anglo-Australian Observatory,
PO Box 296, Epping NSW 2121
Tel: (02) 868 1606, Fax (02) 876 8536

1992

Jan 13 - 31
5th Physics Summer School: Atomic and Molecular Physics and
Quantum Optics, Canberra
B.A. Robson, Dept of Theoretical Physics, R.S. Phys. S.E., ANU, GPO Box 4,
Canberra ACT 2601, Tel: (06) 249 2971, Fax: (06) 249 4676

July 12 - 15
Twelfth International Workshop on Rare-Earth Magnets and their Applications -
Sponsored through Department of Industry, Technology & Commerce by the New
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- Helium-Cadmium Lasers
- Helium-Neon Lasers
- Krypton Ion Lasers
- Lead Salt Lasers
- Mixed-Gas Ion Lasers
- Nitrogen Lasers
- Neodymium:Glass Lasers
- Neodymium:YAG Lasers
- Neodymium:YLF Lasers
- Ruby Lasers
- Titanium:Sapphire Lasers
- Xenon-Helium Lasers

Argon ion Laser from Coherent Inc. (top left)
Diode-Pumped YAG Laser from ADLAS (top right)
Ultrasalt Dye Laser from Coherent Inc. (bottom left)
Helium Neon Lasers from Melles Griot (bottom right)

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- Laser Flashlamps
- Laser Gloves
- Laser Heat Exchangers
- Laser Test Instruments

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- Coherent
- Continuum
  (formerly Quantel International)
- Edinburgh Instruments
- Lambda Physik
- Laser Photonics
  (Incorporating Advanced Kinetics, Apollo Laser, California Laser, Laser Analytics, Molecron Laser & PRA)
- Lee Laser
- Melles Griot
- Omnicron
- SST Optronics

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