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President's Column

As will be obvious from some recent issues we welcome initiatives and comments from members of the Institute on matters of concern such as nuclear armament and warfare. In these the role of the Institute should be to encourage informed debate and to disseminate accurate information; it should certainly not involve any politically partisan stand. I believe that we should attempt to express concern over improper applications of science, and physics in particular, while at the same time we should also vigorously promote the importance and excitement of scientific pursuits.

In expressing concern over abuses of physics we should note the dangers of feeding simplistic anti-science views in the community. This was mentioned in a letter from Professor Colin Keay (July AP) who drew attention to the proliferation of nuclear-free zones. As I drive through Sydney and observe signs proclaiming such zones I must confess to being somewhat appalled because they indicate to me an attempt to solve a major problem by blind opposition to one of the most significant areas of man's knowledge — nuclear physics. Probably the cause for concern is the all-embracing title 'Nuclear-free Zone'. I must confess to smugly wondering if the proponents really refer to an area devoid of nuclei — a state of bulk matter yet to be researched? Of course they don't and, after reading the definitions used by one group, I must be fair. But nevertheless the use of such an unqualified title must smack of anti-science. We have a responsibility to attempt to inform those in authority of the importance of scientific progress and of proper debate on its applications.

In this issue there is reference to some controversy over the reaction of our largest research organisation to public criticism. It is healthy that in a democracy such matters can be debated. I wish to thank the CSIRO and its Chairman, Dr Wild, for the reasoned response which is reported alongside the article.

As is also indicated in this issue there is soon to be a National Technology Summit. The Institute has been given a place among the 120 attendees and we will be making a submission. I would welcome suggestions on this from members but they would obviously need to be sent to me promptly.

Editorial

I have just been reading a seemingly endless series of newspaper clippings on the radiation hazards associated with mineral sands mining and beneficiation, especially at Capel and Eneabba in Western Australia. How depressing! One's perception of facts is highly coloured by one's basic philosophy of life, and in this "debate" we have intelligent people forming opposing lines as they try to suit appropriate actions to the same set of facts.

This situation emphasises that facts can only be assimilated on the basis of experience and background, and that a decision depends as much on related areas of knowledge, and on an overall understanding of the balances involved in the open system, as it does on the set of facts on which attention is currently focused. One needs a sensitive ear to hear the real causes of concern.

I once offered a newspaper editor a series of short, snappy articles giving background to the energy/nuclear power debate, but was told instead to write something topical when the subject next became controversial. Evidently in that editor's view, people do not wish to be adequately informed.

This raises obvious problems for the proper working of a democracy, which seems to depend on the majority of the people being well informed. It also throws light on the MacDonald/CSIRO controversy described in this issue by the Science Policy Committee. All personal interactions seem to be coloured by misunderstandings and by differences in attitude and background which make the facts in question pale into insignificance.

Consensus rather than confrontation is a laudable aim, but it needs both hard work and goodwill to bring it about.

Jim Graham

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Letters

Dear Sir,

The recent letter by Dr. Rachel Makinson about the mock sun (parhelion) that she saw from the Blue Mountains recalls to my mind the water colour paintings of the Antarctic by Dr. Edward Wilson. Wilson was the medical doctor and zoologist with Captain Scott on his polar expeditions and was with Scott on the fatal march back from the South Pole in 1912. Wilson made many pencil sketches and water colours throughout the expeditions. His water colour has a calmness and a repose about them that reflects not only the beauty of the atmospheric effects and colours but also what seems to have been some aspect of Wilson’s character. I saw some of the water colours a few years ago at the Royal Geographical Society in Kensington Grove, London, when I was working in its library. Others are held at the Scott Polar Research Institute at Cambridge. Many of the pencil sketches and water colours are reproduced in Leonard Huxley’s official account of the last Scott expedition which incorporates Scott’s diary. Recently Wilson’s diary has been published including many more water colours. The frontispiece in the diary is a photograph of Wilson, taken by H.G. Ponting, the official photographer of the expedition. Ponting took indoor photographs of individual members of the expedition during the winter. Wilson spent many of these winter days working on his water colours and the frontispiece photograph shows him working on a painting of paraseaenes (mock moons). The painting itself, now in SPR1 is reproduced in Wilson’s diary following page 240. There is also a photograph of parahelia reproduced following page 128; this painting is in the RGS and is probably the one that I recalled on reading Rachel Makinson’s letter. The paraseaene painting is also reproduced on page 258 of volume I of Huxley’s books.

The meteorologist on Scott’s expedition was Dr. G.C. Simpson who has winter lectures on meteorological topics, including demonstrations (Huxley1, volume 1 p.256). Ponting’s photograph of him shows him in a well-equipped laboratory. A large collection of Ponting’s photographs is in his book though the reproduction of the photograph of Wilson is much better in the market diary.3

As Rachel Makinson says, the paraelia and paraseaenae are produced by the refraction of light through a well-ordered collection of ice crystals and the ordering is achieved by the gentle fall of the crystals in a still cold atmosphere. The stillness and the coldness are captured in the Wilson water colours; for some one like myself who has never been to the Antarctic, looking at the water colours gives a feeling of being transported to a very strange land, well beyond ordinary experience. The question of the presence or absence of colours in the paraelia probably can be resolved by a mixture of solid state physics, crystal habits and optical theory. In Wilson’s diary on page 201 is a sketch of the colours of the paraelia on a certain day of the expedition. Wilson was a keen bird watcher and his diary on page 49 records his impressions of his visit to Melbourne when he was en route to the Ross Sea. He enjoyed the Botanical Gardens and was particularly attracted, as are many European visitors, to the Blue Wren.

References
3 Wilson, E.A. 1972, Diary of the Terra Nova Expedition, 1910-1912.
4 Ponting, H.G. 1923. The Great White South or with Scott in the Antarctic, etc. Duckworth.

H.C. Bolton
Physics Department, Monash University, Victoria

Dear Sir,

The call for a nuclear freeze is enticing for it allows some physicists to abolve their guilt? but, more importantly, it provides an opportunity to strike against the insanity of nuclear war. Few would doubt that nuclear war is insane and, probably for that reason, the super powers have spread us this experience so far. It is said that nuclear war is becoming more probable because of the
(a) incredible accuracy of modern missiles which enhances the efficacy of the first strike concept (i.e. counterforce capability);
(b) reduced delivery time to Pershing II missiles in Europe which involves a launch on warning retaliation by the Soviets;
(c) lack of surveillance controls for Cruise missiles.

It sounds right, but is it? We should remember that nuclear submarines, which comprise a large fraction of the US and Soviet strike forces, are believed to be currently immune from first strike. Consequently, the effects of accuracy, delivery time and lack of surveillance control cannot improve first strike efficacy to the extent that it could ever be contemplated.

In recent years the Russians have deployed the SS20 targeted mainly on Europe and the SS18, 19 for the USA. These missiles possess counterforce capability in that they are sufficiently accurate to destroy a large fraction of Western delivery systems, but not submarines.

The Cruise in particular will negate this capability in Europe because of its launch mobility. The Pershing II, however, would require launch on warning (i.e. use it or lose it) because of its vulnerability to first strike. In this sense the Pershing II could be seen to increase the risk of accidental war.

It is the SS20 which has upturned the nuclear balance in Europe and, as a consequence, may have increased the likelihood of war. The NATO response should restore the balance and convince the Soviets that even a limited nuclear war in Europe would be mutually disastrous.

Strangely, no one thought of a freeze during the SS20 build-up, but only for the NATO response. Why wasn’t the time right then? Because in modern democracies it is far easier to be aware of and to influence one’s own government’s actions than those of adversary governments.

So is the time right now? A nuclear arms freeze would leave the USSR the dominant nuclear and conventional power in Europe, resulting in a highly unstable situation.

This year is clearly a turning point in the nuclear arms race. A freeze would stop the race, but would not affect the likelihood of war. On the other hand, the Russians and Americans are showing every sign of talking in the hope of stopping the escalation in Europe. With some good will, Pershing II and Cruise missiles will not be deployed in large numbers, the SS20 will be withdrawn and the probability of nuclear war reduced.

The timing of the freeze is important. A few years ago, before the SS20 build-up, would have been optimum and, if the talks fail, next year will be right. This year the freeze can only undermine the Western position.

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A COMMENTARY ON THE PUBLIC JUSTIFICATION OF PUBLIC RESEARCH

AIP Science Policy Committee

Introduction

The effective use of a nation’s scientific and technological resources to meet national goals and objectives is a problem which confronts all governments. The issues raised by such a problem are very broad and as such are of interest not only to scientists (who might be expected to have a very special interest) but also to professionals in the fields of economics, sociology and philosophy as well as politicians and bureaucrats.

In the case of Australia, one of its greatest scientific and technological resources is the Commonwealth Scientific and Industrial Research Organization (CSIRO). Many Institute members are or have been employed with CSIRO. In common with scientists in many large organisations, it is likely that many of the Institute members in CSIRO have a concern not only for the direction and goals of their own research but also the overall effectiveness of the organisation within which they work. It is also highly likely that many physicists and scholars in general have expressed concern about such things but have wondered how successful they might be in getting their views accepted or even heard within a large organisation. Indeed, a CSIRO scientist in a recent edition of the Australian Physicist proposed that scientific administrators should investigate new organisational structures for the more effective application of research (Pryor, 1983).

The following commentary has the aim of identifying some general issues in science policy which relate to large government research organisations. In particular, this commentary looks at the behaviour of one large organisation, CSIRO, when it was recently subjected to criticism (Macdonald, 1982). The Committee had no reason to doubt or bring into question the important role of CSIRO in improving Australia’s well-being or the way CSIRO justifies the research it carries out. It was thus not the purpose of the Committee to investigate the reasons why that the behaviour of CSIRO in this instance did not benefit the Organisation’s status as the nation’s premier research institution.

The Science Policy Committee, in commenting on this incident, believes that these circumstances raise a number of issues of interest to physicists (and scientists or scholars in general) working in or commenting on large-government research organisations.

Some Science Policy Issues

The first issue in science policy refers to the allocation of resources in large government research organisations, by correspondingly large scientific bureaucracies. As in most areas of government involvement, the decisions which are made are not always correct, and it may be long in terms of the scarce resources (both money and manpower) which are used or mis-used before errors can be corrected.

With these points in mind, it is legitimate and reasonable to ask whether the Australian public is getting its fair return from the resources it invests in CSIRO. Is CSIRO producing the type of information which can be of most use to Australia? There may also be doubts about how well CSIRO inventions are finding their way into Australian history and whether indigenous Australian firms are being given the opportunity to benefit from CSIRO research through licensing arrangements. There have been few objective studies carried to help answer such questions.

The sheer size of CSIRO must clearly have a significant impact on the rest of Australia’s scientific and technological effort. The annual CSIRO budget of over $300 million is similar to the total amount invested annually in research and development by Australian manufacturing industry. In using scarce resources, the Government must be aware of the important influences of CSIRO on Australia’s technological environment.

Given these considerations, it is also reasonable to ask whether the Government is being given management information (not public relations information) of sufficient quality to enable it to make informed decisions about the contribution that CSIRO makes to Australia’s well-being. It may not be adequate to rely solely on the wide range of advisory mechanisms which exist (Wild, 1982). It is only through public accountability that Parliament can satisfy itself that these needs are being adequately met.

The second issue in science policy refers to the behaviour of large research organisations. J R Ravetz has written about ‘big science’ that:

‘Large-scale projects require organisations which are also large-scale, but in addition complex and possessing a tendency to take on a life of their own. Those who have never experienced this phenomenon may find it hard to imagine how people can completely lose sight of the original “mission” of an institution, concentrating solely on immediate problems of position, prestige and patronage. But it happens with deadly regularity; and institutions devoted to “research” are as susceptible as any other.’ (Ravetz, 1982)

The question here is to what extent large research organisations should be allowed to take on a life of their own. If the needs of industry, government and the community at large are to be taken into account, it is very important that effective advisory mechanisms operate. In addition, the ability of scholars outside an organisation to review and research its activities can also be a useful source of information in considering scrutiny from outside:

— to what extent should research organisations be expected to tolerate what they consider to be ill-founded and uninformed criticism?
— should large research organisations co-operate with scholars who wish to scrutinise them and how receptive should such organisations be to criticism arising from such studies or research?

The Science Policy Committee believes that large government research organisations must be prepared to justify their research projects at any responsible level of criticism and should welcome scholarly interest in their activities.

The Example Set by CSIRO

The article by Dr Stuart Macdonald referred to above was titled ‘Faith, Hope and Disparity: An Example of the Public Justification of Public Research’ and was published in Search, the journal of the Australian and New Zealand Association for the Advancement of Science (ANZSAS). The Editor’s summary perhaps best
explains what the paper set out to do:

'Since CSIRO absorbs 16 per cent of Australia's total expenditure on research and development, it is natural to ask to what extent the work undertaken is well chosen. The author examines the justification given for work performed by CSIRO, taking as an example the Division of Entomology. He concludes that, although the scientific quality of CSIRO may well be very high, the arguments publicly presented for the actual deployment of resources are often weak.'

One of the examples used by Dr Macdonald to support his argument comes from his analysis of the dung beetle program run by the CSIRO's Division of Entomology. The dung beetle program dates from 1964 and in general terms the aim was to establish foreign dung beetles in Australia so that they may disperse dung and discourage the breeding of buffalo flies and bushflies. Dr Macdonald points out that a 1972 publication from CSIRO observes that foreign dung beetles were to be introduced because they could cope with the larger, moist pads of cattle dung, while native Australian dung beetles could deal only with the dry pellets of marsupials. In 1978, an official account of the program noted that there were no species of native dung beetle that specialised in using cattle dung as a breeding medium. Yet in 1979, CSIRO officially reported that the study of native dung beetles was to be a primary aim of the program. Dr Macdonald notes that, with this sudden change of emphasis:

'One is, therefore, prompted to ask why, after many years and millions of dollars have been spent importing exotic dung beetles because of the declared uselessness of native dung beetles, it is only now worthwhile discovering how useful they are.' (Macdonald, 1983)

Dr Macdonald claims that his paper does no more than suggest that CSIRO's public pronouncements about its research are inadequate. (Macdonald, 1983) Irrespective of the quality or completeness of Dr Macdonald's work, the events surrounding its publication cannot go without notice. The Editor of Search has noted that:

'The editors and our referees regard this paper as scholarly and of interdisciplinary interest, but this view is not shared by certain areas of CSIRO. The author has been subjected to considerable pressure not to publish ...' (Strahan, 1983)

CSIRO also approached the editors of Search suggesting that Dr Macdonald's paper should not be published because 'it wasn't good enough yet' (Roberts, 1983), and the Chairman of CSIRO, Dr Paul Wild, in commenting on Dr Macdonald's paper said that 'in the meantime, it behoves a Trappist sacred cow to develop its own special acaricide (mite-killer)' (Wild, 1982). This remark was, of course, made 'teque-in-cach' by Dr Wild, and as such should not be taken too seriously.

The attitude of CSIRO's Division of Entomology was clearly stated in its reply to Dr Macdonald's original paper:

'Macdonald's paper offers no solutions and serves only as a vehicle for largely unfounded criticism.'

(Carne, 1983)

Dr Macdonald mentions in his reply to this commentary:

'I regret that Dr Carne makes so much of my visit to the headquarters of the Division of Entomology, for he forces a defence that should have no place in academic dispute. I spent two days discussing drafts of my paper with the Division's senior personnel in Canberra and I am grateful to these people for the time and information they gave. Certainly I was offered access to Divisional records — on condition that my paper was withdrawn from publication. I was told that the latest draft was wrong from beginning to end and that nothing could be salvaged. I was warned that the draft contained particularly serious errors and that I would discover the nature of these only when the Division published its reply. I was threatened with the possibility of legal action and with the ruin of my career and reputation — for what they might be worth — if publication proceeded. There have been better days; indeed, considerable experience of interviewing research staff in high technology and defence organisations overseas has produced none worse. Dr Carne doubts that I have canvassed widely within CSIRO for information, and yet I have been asked to supply all early drafts of the paper together with names and addresses of all those from whom comment has been sought.' (Macdonald, 1983)

Comments

In commenting on the above incidents, the Committee wishes to make two points:

First, a dispute between members of a large research organisation and science policy researchers assessing the value of the research such as the one involving CSIRO outlined above is something which is not peculiar to Australia. Two researchers from the Science Policy Research Unit (SPRU) at the University of Sussex (UK) have recently published a report which claims that the Jodrell Bank radio telescope in England had an extraordinary behind-the-scenes campaign by Sir Bernard Lovell, director of Jodrell Bank for 30 years until 1981, against the report and its authors, John Irvine and Ben Martin (Connor, 1983). The analysis and conclusions of the study were condemned bitterly by Lovell. They claim that Martin and Irvine had proved nothing. The dispute between the radio astronomers and the Sussex researchers has even become personalised with angry accusations and 'name-calling.' One member of SPRU has publicly dissociated himself from Irvine and Martin's reports (Connor, 1983).

This example from the United Kingdom raises similar questions to the CSIRO case. CSIRO is not alone in having to deal with criticism arising out of scholarly research.

Second, CSIRO's alleged behaviour towards Dr Macdonald must be brought into question. The Committee understands that the threat of legal action which was alleged by Dr Macdonald was made by an individual who was associated with CSIRO. In addition, the Committee understands that the approaches made by CSIRO to the editors of Search not to publish Dr Macdonald's paper were 'polite and discreet' (Roberts, 1983).

Given these facts, it is evident that the CSIRO believed it was within its rights to suggest to the editors of Search not to publish Dr Macdonald's paper if it thought that 'it wasn't good enough yet' (Roberts, 1983). The Committee believes that it is improper for any organisation or individual to make a recommendation like this if the paper was already accepted by a journal for publication.

If senior members of CSIRO held this view, then the Committee believes that the proper course of action would have been to publish a reply in an academic journal. CSIRO published a reply in Search (Carne, 1983). This, in matters of dispute, is a proper course of action to set the matter straight. But the Committee does not condone CSIRO's behaviour if as Dr Macdonald claims, he had been offered access to Divisional records on the condition that his paper was withdrawn from publication. The refusal to make information available would make it very difficult for an outsider to assess what the

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organisation is doing. The Committee also does not condone CSIRO’s behaviour, if as Mr Macdonald alleges, he had been asked by CSIRO to supply copies of all early drafts and the names and addresses of people to whom these had been sent and also threatened with the ruin of his career and reputation.

These alleged actions do not appear to be in accord with treating the record straight through a reply in an academic journal. Of course, it could be argued that the threat of the ruin of his reputation which was claimed by Dr Macdonald, may have been implied as being achieved through CSIRO’s response to his original article. However, because of the great disparity between the views held by senior members of CSIRO and the editors of Search about the quality of the paper, this was unlikely to have been achieved. In view of this disparity, these alleged threats could be seen by some to take on a very malicious character.

Conclusion

If Dr Macdonald’s claims of CSIRO’s behaviour are accurate, then the Committee concludes that in dealing with Dr Macdonald’s criticisms, CSIRO has overreacted. While such a reaction may be seen by some to be understandable, this Committee believes that this sort of behaviour, if it did occur, does not befit a reputable organisation like CSIRO.

The most unfortunate consequence of this incident is that it could be into question the ability of CSIRO to respond objectively to criticism. If CSIRO’s alleged behaviour was intentionally threatening, it would surely make any scholar reconsider embarking upon a study of CSIRO. It might also make anyone working within such an organisation doubt the wisdom of criticising organisational goals or effectiveness. Studies in science policy, by their very nature, will involve political points of view and value judgements. If Dr Macdonald’s claims of CSIRO’s behaviour are accurate, then the meticulous research required for any future studies of CSIRO by outsiders would be seriously hindered by the lack of free access to detailed information. Perhaps CSIRO needs to be reminded that science is, after all, public knowledge (Ziman, 1968).

Acknowledgements

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This list supersedes that published in the July issue, p. 156.

CSIRO’S RESPONSE

12 July 1983

Dear Professor Wilson,

I am responding to your invitation to comment on the draft report of the AIP Science Policy Committee on the "CSIRO-Macdonald affair."

It is of course entirely proper that research organisations should be subject to scholarly interest and responsible criticism. It is also appropriate that an institution such as yours should examine the issues raised by Dr Macdonald and the claims about CSIRO’s behaviour following the circulation of his draft paper. These are matters of public concern and should be ventilated.

An unfortunate consequence of this affair relates to perceptions, held both inside and outside the Organisation, of CSIRO’s attitude towards criticism. I know from first-hand experience that many people think CSIRO overreacted to Dr Macdonald for daring to imply that CSIRO was anything but perfect.

CSIRO does have a problem in determining how best to respond to criticism from the developing field of science policy because, as your paper says, political points of view and value judgements are central to such studies. CSIRO’s dilemma is that it wishes to foster this new area of learning and cooperate with its practitioners but at the same time it should not allow serious misstatements about its work to remain unchallenged on the public record. We also have a particular duty to our scientists to support them against unfair attacks.

One way around this dilemma is for CSIRO to encourage practitioners in science policy and related fields to undertake studies of the Organisation. There have been a number of such studies and a good illustration comes from the Division of Entomology. This was a joint study by officers of the Industries Assistance Commission and the Division on the costs and the economic returns on the Division’s work over a 15 year period. While the exercise was at times painful to the participants, it now stands as a contribution to the literature which commands the respect of scientists and economists alike.

Turning to specific matters raised in your paper, there are several points that should be taken into account.

A draft of Mr Macdonald’s paper was circulated quite widely prior to the publication of a substantially amended, final version in Search. It was given to the press and to senior people in government, including the Minister then responsible for CSIRO. It was this early draft that caused CSIRO to react. The final version had deleted from it many of the statements which gave greatest concern to CSIRO and its officers.

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Science and Technology — A Marriage?

John R. Prescott and T.F. Smith

Fred Smith and John Prescott attended the ANU Seminar on "Science Research in Australia — Who Benefits?" Hereis their not entirely light-hearted account of the proceedings.

Almost 150 representative, research-oriented scientists and others braved the fogs of Canberra at the end of June to discuss "Science Research in Australia: Who Benefits?" at a conference organised by the ANU Department of Continuing Education. Among them grazed the sacred cows: CSIRO, ANU, Defence Science and the geriatric ASTEC and ARGS. Sacred cows? geriatric? Well, so said a surprising number of voices.

Australia has an excellent record in pure research but its commitment to the transfer of the results of that research to technology is virtually nil. Airing of this theme occupied most of the time of the Conference, and a significant fraction of the discussion sought to determine who was to blame! Fewer claimed to know what to do about it.

It seemed to be accepted that pure research was alive and relatively healthy although, even allowing for the hidden costs, the direct funding of University research by the ARGS and NH&MRC looked pretty pathetic in comparison with the money spent by CSIRO, the Department of Defence, Telecom and the AEC. A speaker from the floor deplored the fact that the Institute of Technology got no money at all for research.

Professor Bob Porter, Director of ANU's John Curtin School of Medical Research stoutly defended the national and international standing of Australian medical discovery and pointed out that here was one area where developments useful to the community were most likely to make the transition from the laboratory to practice; and when they do they will be international in scope. Nevertheless the obvious social benefit does not necessarily lead to major economic advantages for Australia.

Australia gains most of its foreign exchange from agricultural and extractive industries. It is therefore not very surprising that these areas have received benefit from research. Some 34% of the budget of CSIRO goes into research in the rural industries and 16% into minerals, energy and water resources. Dr Paul Wild, Chairman of CSIRO, acknowledged that these were the areas where his organisation had been most successful. He added that it was less successful in the transfer of ideas to manufacturing industry.

Dr Stuart Macdonald of the Information Research Unit of the University of Queensland accused CSIRO of not trying. "CSIRO information services answered more queries from school children in a year than it did from manufacturing industry", he said. As for high technology industries, CSIRO spends only about 5% of its budget in that area. Macdonald was also responsible for the best figure of speech at the conference, likening CSIRO to a grand old battleaxe: too expensive to convert and too valuable to scuttle. Wild pointed out that changing direction takes time and that CSIRO's emphasis was gradually shifting from the primary through the secondary to the tertiary and quaternary sectors. "Nevertheless", as Dr Greg Tegart, Secretary of the Department of Science and Technology pointed out, Australia's real priorities are nowhere better reflected than in the number of field officers employed in Australia: 1100 in agriculture, 8 in the metal industries.

Another group to benefit from research is the researchers themselves. As someone put it, "Research is enjoying yourself at government expense". If to enjoyment one adds peer approbation and promotion then a fairly large proportion of the Australian research community is doing well. The trouble with this, as Ann Moyal, Honorary Editor of Search, pointed out is that the judgements on what research is worth doing are made by a very small group of aging, academically oriented individuals whose names crop up over and over again in ARGC, ASTEC and elsewhere. It appears very difficult to get new blood (and new ideas!) into decision-making and it is not at all that easy for young scientists to get their feet on the funding ladder.

The system is therefore, if not actually incestuous, at least self-perpetuating. Not nearly enough attention is paid to social and community criteria in assessing the worth of research fields. This concern was echoed by Mr Leon Peres of the Political Science Department, Melbourne University, Dr Mark Diesendorf, speaking as an individual and Prof. Ron Johnston of the Department of History and Philosophy of Science, University of Wollongong. Moyal also pointed out that women were grossly under-represented in the councils of science.

Ironically, it appeared that it was because of its success that the pure research sector came in for so much criticism. It was as if the pure research workers were in some way to blame for the lack of development. Little, if any, recognition was given to the distinction between the roles of the pure scientist in the discovery of new knowledge and the engineer in its application. While there may be grounds for directing criticism at the policy makers of CSIRO for their failure to direct more effort towards the needs of industry, it is unfortunate that the university research sector has also been subject to the same degree of criticism. While it is true that more contact between university and industry is desirable, nevertheless it should be recognised that the major function of university research programmes is in the training of higher degree students.

This is not to deny that there are intellectually demanding research problems of value to industry that could be performed in universities, but generally these are more suited to the areas of engineering rather than pure science.

Ron Johnston claimed that foreign companies and economies were also among those who benefited by our science research — by default. So long as the production system is dominated by overseas companies with a small commitment to local development, there was little demand that could influence or reorient the research system. We therefore imported our technology and exported the profits.

Manufacturing industry itself was strongly criticized for its lack of commitment to R & D. Among the 150 delegates, there were but seven representatives of this sector. Dr Peter Farrell of the Centre for Biomedical Engineering, University of N.S.W., compared the expenditure of $181.82 of $343 million on R & D with other industrialised countries and concluded that it should have been $2 billion or higher. Out of twenty-four countries in the OECD, only one spends less on R & D. As someone pointed out, that one isn’t New Zealand (a remark doubtless prompted by Mr Muldoon’s presence in Canberra at the time). Sir John Wilson of A.P.M. acknowledged the facts but in partial defence pointed out that it was not traditional in Australia to put risk capital into the manufacturing sector as it was into mining, but he could see no reason why some of this money should not be available. Otherwise, the cost of R & D comes out of profits. This is “safe”. If the new
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project bombs out, dividends may be lower but the firm is at least still in business; whereas if the R & D were undertaken on money borrowed through the conventional channels, failure of the project might well mean bankruptcy. But profits need turn-over and that means international markets, which we don’t have because we don’t put enough into R & D. So the circle closes.

So much for the critics. There were, however, a number of contributors who not only maintained that our national priorities ought to include a much higher input of funds and manpower into industrial R & D but who had suggestions as to what to do about it:

Farrell maintained an “incorrect” optimism: Australia’s future well-being depends on being able to move quickly and efficiently away from low-growth, non export oriented, highly protected, low-technology industries into high-value-added, export oriented, high and new technology industries. This requires the collaboration of all the aforementioned sectors and the process will be long-term and both socially and economically dislocating.

In moving the economy to high technology, the government must act as the prime-mover, as the initial catalyst; the private sector must then take the ball and run, aided and abetted by the other sectors.”

Two speakers eloquently presented public sector ideas. They were Dr Peter Ellery, Director of the South Australian Ministry of Technology and Barry Jones, Federal Minister for Science and Technology.

Ellery enthusiastically outlined the proposals of the South Australian Government for developing high technology industry in South Australia, in particular, to the creation of a “Technology Park” to nurture this sort of enterprise. It represented what may well be the best thought-out of the State Government enterprises in the field.

The Federal Minister, in his address, further emphasised the by now familiar theme of Australia’s creditable performance in R and dismal failure in D. Critical of both industry and CSIRO for their failure to adopt a more progressive attitude to technological change, his cutting remarks, while often raising a laugh, were nevertheless sobering in their implications for Australia’s future if changes did not occur. While pointing out that the Government can do a lot to encourage the interaction between the research organisations, industries and the all-important providers of venture capital, the Minister made it quite clear that the Government expected the management in these areas to take up the challenge of making technological transfer work. As a guideline for development of new, high technology industries, which will be crucial for the maintenance of the wealth of the country as the traditional industries decline, the Government has highlighted sixteen areas in which it considers it likely that there is the best prospect of success. These are the so-called “sunrise” industries.

While it was encouraging to hear such an enthusiastic presentation of the Government’s Science and Technology policy, one could not but wonder how impressed the captains of industry and finance are by it all.

The Shadow Minister of Science & Technology, Dr Harry Edwards, was also at the Conference. He didn’t get the time or the coverage of Barry Jones but one got the impression that this area in the Opposition is adequately covered. And while on political matters, Professor Arthur Birch confessed to having taught chemistry to both Barry Jones and Margaret Roberts (now Thatcher) but took no present responsibility for either.

Perhaps the most curious statement of the whole conference was a throw-away line from Professor Ian Ross, Deputy Vice-Chancellor of ANU, who declared that he was leaving ANU out of the discussion because the theme of the conference didn’t apply to it! Maybe ANU doesn’t have a brief to revitalise high-technology industry, maybe its research topics should lie exclusively in the curiosity-oriented area. Nevertheless it does not hold a monopoly on training future academics, nor will all its graduates live out their lives in the ivory towers of Academe. As Professor Ross himself pointed out, the major marketable scientific resource produced by the universities and the institutes of technology is people. It was left to speakers from the audience to bring this point home and this is perhaps the most important point for the AIP. Unless Australia produces enough scientists and innovative engineers to staff the sunrise industries, the rising sun will plop ignominiously back into the sea.

Envoi

One of us (JRP) was present at the ANZAAS meeting in Canberra in the early fifties when exactly the same discussion took place. There was an unhappy sense of *deja vu* only the *dramatis personae* had changed; and one wonders if we shall go through it all again thirty years on. Which assumes that we are still in a position to address ourselves to such questions and have not already become, as predicted in 1978 by the late Dr Herman Kahn, “a degenerate, collapsed society.”

Fred Smith is Professor of Physics at Monash University and is Vice-President of the AIP. John Prescott is Professor of Physics at The University of Adelaide and is Chairman of the AIP Employment Committee. Although both hold AIP office, the views they express here are personal views and not necessarily AIP Policy.

### Link between Murdoch and Malaysia

Physicists at Murdoch University are contributing to a revision of external teaching in physics at the Universiti Sains Malaysia. Two physicists from USM, Dr Lee Beck Sim and Mr Yusoff Mahmod, are at Murdoch during August-November 1983, to broaden their experience in the design and teaching of physics courses for external (off-campus) students.

Two aspects of Murdoch’s experience in external teaching of physics are of particular interest to USM. Murdoch has based the physics practicals for external students almost entirely on off-campus loans of equipment, ranging from items for simple experiments in mechanics to microcomputers for programming studies. Murdoch’s physics courses are designed for “personalised instruction” (PSI), using modified Keller plans which are readily adaptable for external students. These approaches to practical work and course design will have longer term relevance to the progressive redesign of USM courses, although at present the USM external students attend local study centres and an annual session.

Mr Mahmod’s previous experience includes MSc in geophysics and planetary physics (Newcastle, UK); Lee Beck Sim completed his PhD in theoretical physics at Monash University in 1971. Collaborators at Murdoch include Professor Bruce Mainsbridge, Associate Professor Philip Jennings, Dr Bruce Cornish and Dr Mary Dale. The project is sponsored by USM and AUDIP (Australian Universities International Development Programme).

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INDUSTRIAL RESEARCH AND DEVELOPMENT CONTINUES TO FALL

AIP Science Policy Committee
AIP Employment Committee

The AIP Employment and Science Policy Committees have an interest in industrial research and development (IR&D) from different but related perspectives. Employment Committee surveys have shown an increasing number of Institute members taking jobs in industry, but this increase is over a very small base. The Science Policy Committee has a broad interest in IR&D as a component of science policy.

The interests of the Committees intersect in the role physicists can take in IR&D and, more generally, in industry development. Australian industry, particularly manufacturing industry, is in decline, and a good deal of this decline is structural rather than cyclical. In 1965, manufacturing employment was 27.6% of the paid labour force; in 1982, it was less than 17% (1). In absolute terms, manufacturing employment over this period has remained roughly constant at about 1.3 million, although it has fallen from 1.25 million to 1.15 million over the last 12 months (2). Over the 17-year period however, the labour force has increased from 4.5 million to 6.7 million. Economic recovery, if and when it occurs, is unlikely to restore industry to its former relative importance as an employer.

One of the few rays of hope is that high technology industries, the so-called “sunrise” industries, might generate sufficient wealth and employment on a national level to at least ease the pain of structural adjustment. Most of the sunrise industries nominated by the Australian Labor Party (ALP) (3) would require appreciable numbers of physicists in areas ranging from IR&D production, technical support and marketing.

Against this background, the AIP Employment and Science Policy Committees are concerned by the results of the latest Australian Bureau of Statistics (ABS) survey of IR&D (4).

Industrial research and development (IR&D) fell during the three years to 1981-82, according to preliminary figures released recently by the ABS. Expenditure — $334 million in current prices — has fallen in real terms by 2%, and IR&D manpower — 8100 man-years — (5) has fallen by 7%, since 1978-79 (6). These falls follow a trend which has been evident since the early 1970’s; in 1978-79, expenditure was static compared to 1976-77, but IR&D manpower fell by about 7%, and in the three years to 1976-77, expenditure fell by almost half as compared to 1973-74 (7) (8).

This long-term decline in IR&D augurs ill for the industrial future of Australia, and it has been a matter of concern to Commonwealth and State Governments for at least five years. The major response of the Commonwealth Liberal/NP Government was to increase its appropriation for the Australian Industrial Research and Development Incentives Scheme (AIRDIS) from about $14 million in 1977-78 to about $50 million in 1980-81 (9). The 1981-82 results thus represent the first opportunity in Australia to test the hypothesis that increased government incentives for IR&D result in increased amounts of IR&D being undertaken.

The results must be a substantial disappointment to those who believe governments are capable of influencing such matters. IR&D expenditure did not increase at all. At best, having regard to the uncertainties in the data, it remained constant, but it is more likely that the fall is real (see note 6). There are three possibilities: R&D expenditure would have fallen much more if the incentives had not been in place; Government R&D incentives do not change the level of IR&D being undertaken, they merely substitute government funding for industry funding; and most satisfyingly for economic “dries”, the more governments encourage IR&D the less industry does it.

AIRDIS was reviewed twice by the former Liberal/NP Government in recent years; firstly as part of that Government’s consideration of the Report of the Committee of Inquiry into Technological Change in Australia (CITCA) (10), and then by the Industries Assistance Commission (IAC) as part of its reference on Certain Budgetary Assistance to Industry (11). The CITCA report resulted in Government decisions to continue AIRDIS for five years from 1981, increase the grants, and a number of administrative rearrangements. These decisions were embodied in the Industrial Research and Development Incentives Amendment Act 1981. The IAC in its report found by a 6-1 majority (the then Chairman McKinnon dissenting) that the scheme was making a sufficiently effective contribution to the Government’s industry policy. One can but speculate on the effects the ABS results would have had on the views of the IAC Commissioners.

The results do not provide any joy for the new Labor Government either. ALP policy is to make the R&D incentives grants tax-free; in effect an increase in government IR&D funding. If a very substantial increase in taxable grants failed to raise the level of IR&D in Australia, for whatever reason, prima facie a further increase, by making the grants non-taxable, would also fail.

The ABS results also provide some indirect comment on sunrise industries, those high technology generators of wealth and employment that have been indicated by the Minister for Science and Technology, Barry Jones, as being the path to economic survival in the long term. Sunrise industries are generally regarded as requiring a “Silicon Valley” like infrastructure if they are to flourish — hence the enthusiasm of a number of governments for technology parks. More generally, however, one could look to existing Australian industries that can be expected to provide inputs to the sunrise industries to see if they are capable of providing the necessary infrastructural support. It seems reasonable to suppose that the level of R&D performance within an existing industry is a measure of its capacity to provide this support.

Simple examination suggests that a healthy majority of the sunrise industries identified so far by the ALP (3) are likely to draw much of their infrastructural support from industries which would be classified by ABS as “photographic, professional and scientific equipment” and “electrical and electronic”. So, if sunrise industries really do have a future in Australia, we would expect to see R&D performance in the infrastructure industries holding up, even if IR&D performance overall is declining. Regrettably, the results are precisely the opposite. The level of R&D in these infrastructure industries declines much more than in industry overall. R&D manpower in the photographic, professional and scientific equipment industries fell by 28% over the three years to 164 man-years in 1981-82, and in the
electrical and electronics industries, by 29% to 880 many-years in 1981-82.

The implications for the sunrise industry policy are not good. The ABS results suggest at the very least that in addition to supporting the industries themselves, governments may have to take a greater role than at present in ensuring the appropriate infrastructure is in place. This of course makes the bill much larger than it otherwise might have been, and the political difficulties in instituting a sunrise industry policy correspondingly greater.

As Barry Jones reminds us, governments that put money into sunrise industry development have got to be prepared to incur losses, and possibly to lose their entire stakes. The sunrise way, the argument goes, at least provides some chance; in the alternative, there is none. Preference to sunrise industries is justified by the need to "inject" high growth areas into the economy. By implication, the benefits of sunrise industries will diffuse throughout the economy without any special or additional government attention.

The traditional economic view opposes support for sunrise industries. The *Australian Financial Review* was blunt: sunrise industries are "technological pipe-dreams" (12). A discussion paper issued recently by the IAC (13) was at least more circumspect. It took the view that whether or not sunrise industries have any place in Australia's economic future, governments have no business providing any kind of special assistance to them, because such assistance necessarily distorts the market's allocation of resources, and so reduces the wellbeing of the community as a whole.

One way of overcoming at least some of these objections (and overcome, not ignored, they must be) is to adopt a "key technology" policy (14) whereby special assistance is available to any firm in any industry provided it adopts selected "key" technologies such as microelectronics, robotics and biotechnology. Under this approach, the task of selecting sunrise industries is more or less replaced by the task of selecting key technologies. Nevertheless, the sunrise industries are obviously well placed to receive substantial assistance from such a policy. However, diffusion throughout the economy is encouraged by allowing existing industry, to the extent that it is willing and able to adopt "key" technologies, to benefit also. In view of the infrastructure problems suggested by the ABS survey, the key technology approach could be more appropriate. It may be that sunrise industries cannot be "injected into" an economy, but that they must grow out of it: that governments are mere gardeners, not physicians.

Notes and References

1 B Jones, Speech to National Science Forum, Canberra, 5 April 1983.
3 Australian Labor Party, "Science and Technology Policy 1983". The "sunrise" industries are: biotechnology, personal computers, computer software, custom-made computer chips, scientific instrumentation, medical technologies, lasers, communication technology, industrial ceramics, solar technology, shape memory alloys, fusion, robots, intermediate technology projects, hydrogen generation and storage, and biomass. The ALP does not regard this as an exhaustive list.
5 "IR&D manpower" refers to the man-years of effort devoted to IR&D in a particular year. It includes both researchers and technical and other staff supporting IR&D.
6 The survey figures should be interpreted as "best estimates" only. ABS advice is that it is difficult to establish the precision of the survey, owing to reporting errors such as inconsistent interpretations of "expenditure" as between respondents and by the same respondent as between surveys.
10 Committee of Inquiry into Technological Change in Australia, "Technological Change in Australia", Vols I-IV, AGPS, Canberra, 1980.

An ear for a galactic message

It is conceivable a message or signal from space could contain the solution to one of mankind's problems.

'This is Planet X and this signal is generated by a safe energy source far more powerful than nuclear fission. We have safely passed through and beyond the Nuclear Age.'

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The odds against hearing an extra terrestrial message are probably billions to one.

For one thing, astronomers say, we are not listening very intently. For another, Earth is creating so much of its own chattering that there is no such a project, says Dr David Jauncey.

However, he and Dr Bill Peters are trying to lessen the odds with a 'tiny illuminated hearing aid'.

The 64-metre dish antennas at NASA's Tidbinbilla space tracking station is tiny compared with the immensity of our galaxy and the 'needle in the haystack' process of catching the one frequency in millions that the message may be on.

Tied up

The best radio telescopes in the world are tied up with too many projects to be spared 'spending a lot of time putting an ear to space' despite the fact that such a project would be scientifically valuable in teaching us to be alert and 'develop the technology to listen to space,' they say.

The Second Seeheim Workshop on Mössbauer Spectroscopy

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An outline of the above meeting which marked the twenty-fifth anniversary of R.L. Mössbauer's discovery of recoil-free nuclear resonant absorption is presented. A feature of the conference was a talk by Professor Mössbauer in which he reminisced on events leading up to his discovery.

The formal history of the Mössbauer effect dates from 9 January 1958. This was the day on which the German journal "Zeitschrift für Physik" received the manuscript of R.L. Mössbauer (1958) in which he reported the first observation of recoil-free nuclear resonant absorption as manifest by variable temperature measurements on γ-radiation using the $^{151}$Ir isotope. The year 1983 is therefore the twenty-fifth anniversary in the continued development of the technique and, as such, was marked by the second in the series of Workshops on Mössbauer Spectroscopy at Seeheim, the first having been held in May 1978 to mark the twentieth anniversary of Mössbauer's reporting of his discovery. Both of the meetings have been held in the superb venue provided by the Luftfahrt Training Centre at Seeheim in the wooded mountain area of Odenwald, some 40 km south of Frankfurt.

The three day workshop (23-26 May), or as it should more properly be called, conference, was attended by over 180 delegates — about fifty per cent more than attended in 1978. Mössbauer Spectroscopy is one of Germany's main research fields and, as is to be expected of a meeting arranged by German scientists to honour that country's only living Nobel prize-winning physicist, the conference was dominated by German scientists who numbered over half of the delegates. As shown by the following attendance figures, there was a sharp dependence of the number of delegates in attendance from a particular country on the proximity of that country to Germany: — England (13), France (11), Netherlands (10), Poland (6), Belgium (5), rest of Europe (22), Americas (4) with a solitary delegate from Australia. The excellent organisation of the conference was undertaken by a local committee under the chairmanship of Professor P. Gutlich (Mainz) with co-chairman Professor G.M. Kalvius (München) and under the guidance of an International Committee of ten members drawn from senior scientists in the fields of Mössbauer Spectroscopy and Hyperfine Interactions from countries in Western Europe.

As already indicated, the meeting took a form which could be considered to be standard for conferences. There were twenty-four invited talks spread over two and a half days, an evening poster session, an afternoon panel discussion on biomolecules and, of course, the conference dinner which in this case took the special form of a twenty-fifth birthday party.

As explained by Professor Kalvius in his opening remarks to the conference, the invited speakers, on the whole, represented the second and third generation workers in this field rather than the first generation of Mössbauer spectroscopists as on previous occasions of a similar nature. The exception to this was, of course, Professor Mössbauer himself who represented the zeroth generation of the effect. Apart from his scientific address on Temporal Aspects of Absorption and Scattering, Professor Mössbauer gave a brilliant talk at the birthday party as he reminisced on the heady days just before and after the submission of his 1958 papers. The affection and regard in which Professor Mössbauer is held by his German colleagues was evident by the way in which he was referred to either as the "Father" of the Mössbauer families or the "Master" of the technique.

Talks

As far as possible the organisers arranged talks on like
subjects in groups of three by thirty-five minute presentations. Typical of these groups were the talks by Spiering (Mainz, FRG), Parish (Manchester, England) and Trautwein (Lubeck, FRG) on applications in chemistry in which they covered respectively: spin transitions in iron complexes, the systematics of $^{199}$Au Mössbauer parameters in organogold (I) compounds and theoretical methods for evaluating the vibrational, electronic and magnetic structure of compounds which contain Mössbauer isotopes.

The opening set of talks was generally on the theme of surface effects: Morup (Technial University of Denmark) demonstrated clearly how spectra of magnetic microcrystals with dimensions below about 0.1 μm (1000 Å) may, for several reasons, be affected by particle size effects. Among these influences is an increase in magnetic splitting for single domain particles due to the demagnetising field and a reduction in the splitting for smaller crystals due to collective magnetic excitations. The overall pattern is further complicated by the difference in the magnetic hyperfine field between surface atoms and those in the interior of the crystallites and the influence of exchange anisotropy for microcrystals which are in close contact. The elucidation of these competing magnetic effects in microcrystals was followed by a fine summary by Meisel (Mainz, FRG/Nijmegen, Netherlands) of the advantages of Mössbauer spectroscopy in providing details of corrosion products and processes. The main features are the non-destructive nature and different surface depths available to Conversion Electron Mössbauer Spectroscopy (CEMS) of thickness range ~ 100 — 100 Å and γ-ray scattering or transmission of penetration depths to ~ 100 μm. The further advantages of CEMS when combined with an electron-energy analyser under UHV conditions to produce energy differential γ-ray spectroscopy (DCEMS) with 2% energy resolution in the range of 0-10 keV, was outlined by Keune (Duisburg, FRG). This method is based on the fact that the energy of conversion electrons which emerge from the surface after having experienced inelastic scattering in the solid is related to their depth of origin below the surface and is therefore a useful technique for depth-selective analysis of iron surfaces.

In his keynote address to the conference, Professor Mössbauer spoke in detail about the similarities and differences between measurements of emission, absorption and scattering and how they provide information on the motional behaviour of particles in condensed matter. He compared, for example, neutron scattering with its advantages in frequency and scattering K measurements which provide information on the dynamical behaviour of such particles in terms of correlation functions but at the expense of resolution, with the high resolution provided by Rayleigh scattering of Mössbauer radiation but with its restriction to elastic only events. Professor Mössbauer emphasized the important role that the duration of the collision plays in scattering experiments. The general trend of his talk coupled with the absence of Mössbauer spectra in his presentation — the only speaker to show no spectrum — appeared to reflect the extent to which his current interests and thinking have been influenced by his exposure to neutron scientists during his five year period as director of the Institut Laue-Langevin, Grenoble.

The application of Mössbauer spectroscopy to the study of amorphous materials was covered in three talks by Varret (Le Mans, France), Campbell (Canberra/Saarbrucken, FRG) and Wagner (Saarbrucken, FRG). Professor Varret outlined how, in the general case, a texture-free spectrum can be obtained for any textured sample by superposition of four spectra taken with the absorber sample at certain orientations to the γ-radiation. This valuable aid to experimentalists allows truly random spectra to be obtained and thus eliminates, for example, the line intensities problem in the analysis of distributions of magnetic hyperfine splitting. The question of distributions of hyperfine parameters was developed by Dr. Campbell who, besides reporting on the work of the ANU group in this field, also outlined the usefulness of the approaches of Window (1971) and Price (1981) in deconvoluting such distributions. A particularly helpful contribution to this problem has been made recently by Le Caer of Nancy, France and his co-workers at Nancy and Saarbrucken. They have derived a validity diagram with dependent and independent axes $\Delta H$ and $\alpha_0/H$ respectively. The ratio of the average quadrupole splitting $\alpha$ to the mean hyperfine field $H$ indicates the extent to which deconvolution techniques based on first order perturbation theory can be applied. The ratio of $\alpha_0$, the width of the distribution to $H$ indicates the degree of overlap between lines in the spectra and thus provides a quantitative statement of the spectral resolution. Calculations by Le Caer et al. (private communication, 1983) for an assumed normal distribution of magnetic hyperfine fields show clearly when the combination of the perturbation and overlap effects produce distortion in the distributions deconvoluted from Mössbauer spectra. Dr. Wagner also reported on his work on the development from Mössbauer spectra. Dr. Wagner also reported on details of the development of the validity diagram but the main part of his talk was directed to the recent work of Professor Gomber's group at Saarbrucken concerned with understanding the important aspects (both from a fundamental and technological point of view) of re-crystallisation of amorphous metals. Careful CEMS measurements on both the rough and smooth surfaces of amorphous ribbons produced by the melt-spinning technique showed that the onset of crystallisation occurs first at surface layers on the exposed, and therefore relatively slowly cooled, smooth surface of the ribbons.

Dr. Petry (Grenoble, France) outlined his recent work with colleagues on the study of diffusion processes in metallic single crystals at temperatures approaching the melting point. If a Mössbauer atom performs one or more jumps during the lifetime of its excited state the corresponding resonance is broadened. Also, if the atom performs jumps on a discrete lattice, the phase shifts of the emitted γ-wave depend on the angle between the
direction of emission and the lattice directions. Their research on the diffusion of iron impurities in single crystals of aluminium has literally added a new dimension to the study of diffusion processes as the anisotropy of the line broadening which can be measured in a single crystal is characteristic of the geometry of the diffusion lattice. Diffusion studies of a different kind were described by Salomon (Bochum, FRG) who in his talk on metallurgy, diffusion and Thalliumneus explained that only a small fraction of the gaseous impurity (~ few hundred ppm) in the metal matrix was sufficient to broaden the very narrow 6.2 keV $^{111}$Ta resonance from its natural linewidth of 0.0065 mm$^{-1}$ to ~ 0.1 mm$^{-1}$.

One of the most outstanding features of the Mössbauer effect is the seemingly unlimited way in which the effect continues to find new areas of application. For example, Biezel (Munich, FRG) described the phenomenon of "Quantum Beats" - a time structure which occurs in the counting rate when Mössbauer radiation is phase-modulated (by mechanically vibrating the source) and allowed to pass through a resonant filter. The Fourier amplitudes of quantum beat spectra are very sensitive to the energy shift between absorber and source lines; the method is therefore well suited to precise measurements of small energy shifts and its application to red to infrared experiments was outlined. A further relatively new application was the study of the evolution of metal clusters in solid argon matrices by Pasternak (Tel Aviv, Israel/Leuven, Belgium). Experiments take place by continuous condensation of argon and metal vapours on a beryllium substrate at 6 K and, by studying the formation of such clusters as Fe(_2_4), Cu(_2_4), this should lead to clarification of bulk solubility behaviour.

A more conventional application was described by Wagner (Munich, FRG) in a review of the work of his group on Mössbauer studies of transition metal-hydrogen systems. Hydrogen atoms mostly occupy interstitial sites. The measured isomer shifts and electronic quadrupole interactions reflect mainly the hydrogen distributions in the vicinity of the Mössbauer atoms which are present as substitutional probe atoms. Perhaps the main interest, however, centres on dynamic phenomena as the rate of the hydrogen diffusion jumps changes by many orders of a magnitude within the accessible temperature range. The fluctuating lattice distortions induced by the interstitials can result in a partial destruction in the coherence of the γ-rays, leading to an anomalous and often quite abrupt decrease of the recoil-free factor when the interstitials become sufficiently mobile. Analysis of these results by models which allow for (i) the variation of the mean time of stay of hydrogen atoms with temperature and (ii) instances of attractive as well as repulsive interactions, enabled a detailed description of the dynamic processes to be obtained.

Posters

The formal poster session was held on the first evening of the conference, with posters remaining on display for the remainder of the meeting. Despite the restricted space available for presentation the posters were of a uniformly high standard. The following breakdown of the topics covered by the seventy-nine posters presumably reflects approximately the current interests of Mössbauer spectroscopists in Europe: - chemical structure and bonding (15), biological systems (12), metallic and semi-metallic materials (9), disordered materials (9), radiation damage (7), methodology (5) and lattice dynamics (4) with after-effects, catalysis, mineralogy and special applications totalling a further 10 posters.

The work presented in the posters reflected the great diversity of topics which can be studied by Mössbauer spectroscopy and among the posters which caught my attention were (i) the first Mössbauer evidence for the spin-flip transition which occurs at ~ 123 K in chromium (0.4 at% $^{111}$Sn in Cr; first order transition), (ii) the use of radio frequency fields to induce magnetization reversal in ferromagnetic amorphous metals; this leads to collapse of the magnetic hyperfine structure enabling the measurement of the quadrupole split spectra in the ferromagnetic state, (iii) the use of Rayleigh scattering of Mössbauer radiation in the study of structural dynamics of biomolecules and (iv) the study of the nucleus of erythrocytes clad with magnetite in the pigeon skull; these small masses of magnetite appear to act as sensorial centres for the earth's magnetic field.

25th Birthday Party

Despite the many good features of the formal part of the conference, the highlight for me was undoubtedly the party held to mark the silver anniversary of Mössbauer's discovery. This was not just due to the bounteous supply of food and drink but rather to the already mentioned brilliant talk given by Professor Mössbauer as he told us of his lead-up work in the years before the submission of his 1958 papers.

It was interesting to learn, for instance, that his association with nuclear resonance began with his Diplomarbeit studies in April/May 1953 under the guidance of Professor Maier-Leibnitz at Munich and that two crucial experiments were first carried out in 1956 during his doctorate studies at the Heidelberg Max-Planck Institute. The intensity difference which he then measured, 1 part in 10$^4$, had an error of 3 parts in 10$^4$ but his confidence in the tube electronic equipment which he had largely built himself was such that he considered the effect to be a real one. Nonetheless such was his appreciation of the significance of the result that he spent a further year trying, in his own words, "to kill the effect" to ensure that the apparent resonance was not merely an artefact of the experiment. Professor Mössbauer emphasized the difference from today's conditions by explaining that there really was little or no money for research and, as a result, "stealing" was very popular. He jocularly revealed that he was "actively involved in stealing" and cited instances of loose, unattended equipment (such as the sole cathode ray oscilloscope available for one hundred students) which commonly went missing for long periods. This even extended to blocks of concrete which Mössbauer used as part of the shielding for his experiments, with the 3 a.m. disappearance of these blocks, and their subsequent reappearance some months later on completion of his experiments, baffling the Institute's administrators.

A further exciting revelation concerned Mössbauer's own realisation, on proudly re-reading his first paper in Zeitschrift für Physik some months after its submission, that the resonance effect would be most clearly manifest on introducing a Doppler shift in energy between source and absorber, as a relative displacement of the recoilless lines would cause the absorption effect to disappear completely. That he was the first to introduce this forerunner of the standard method for Mössbauer spectroscopy is well known (eg. Frauenfelder, 1962). What perhaps is less well known is the sense of urgency, almost panic, that surrounded him as he attempted this experiment in the knowledge that many groups, particularly in the USA, were now actively pursuing his new direction in nuclear resonance studies. The rather "bumpy" appearance of the resonance data is, he explained, attributable in part to the mismatch of gears used for the velocity drive; the gears having been
obtained cheaply and quickly from toy shops in Heidelberg.

There were many other equally fascinating facets to Professor Mössbauer’s talk which could be related here if space permitted. His account reminded me of the equally exciting scientific reporting by Hanna (1981) of the part Hanna and his co-workers played in the discovery of the magnetic hyperfine inter-action in the Mössbauer effect of $^{57}$Fe. It is to be hoped that Professor Mössbauer will someday soon develop the theme of his talk by providing a full written account of the background to his discovery.

Further absorbing contributions to the success of the party were provided by Professor H. de Waard (Groningen, Netherlands) and Professor B. Gonser (Saarbrucken, FRG), two stalwarts of Mossbauer spectroscopy. Professor de Waard provided the gathering with the obligatory party game which had the appropriate (but elusive!) theme of “Silver Gamma Resonance”, while Professor Gonser treated us to a slide show of people and events from previous Mössbauer conferences. Professor Gonser concluded his entertaining talk with a brief look at the future in which he foresaw the 1985 conference being held in Belguim and the prospect of a 1986/7 conference in Australia. This latter point was the theme of a poster which I presented at the meeting with the intention of bringing this possibility to the attention of the Mossbauer spectroscopists in Europe. There was clearly a great deal of interest and goodwill expressed by many delegates to this idea but inevitably the discussions turned toward the question of travel costs and likely financial support for persons attending an Australian conference. It is intended that Dr. J.D. Cashion (Department of Physics, Monash University) be the organizing committee member for an Australian conference, will submit a formal proposal along these lines to ICAME, the International Conference on the Application of the Mössbauer Effect, at the coming Mössbauer conference in Alma Ata, USSR (26 Sept.-1 Oct. 1983). It is clear that costs will be a very important, if not the most important, aspect of the proposal.

The concluding remarks by Professor Kamelekei (Darmstadt, FRG) were strangely out of character with the rest of the meeting as his talk showed little sign of preparation and attention to presentation. He barely spoke on the content of the meeting but rather spoke mostly about the time of his own involvement in the field in the early sixties. Nonetheless he made several important points: the tremendous impact which Mössbauer’s discovery made on the development of physics in Germany; the substance of Mössbauer spectroscopy as demonstrated by the continued expansion of the field and the apparent absence of a saturation effect which commonly occurs in research topics; its cross-disciplinary and educational value and finally the observation that the bad weather which plagued the conference (it rained heavily throughout) was probably a factor contributing to its success.

Following the success of the meeting, the organizing committee have decided to publish the proceedings of the Seeheim meeting (texts of all oral presentations and a list of title and authors of the poster contributions) under the editorship of P. Gutlich, G.M. Kalvius and W. Zinn. A third Seeheim meeting is already scheduled tentatively for the thirtieth anniversary in 1988. For anyone with a long-term five year plan for an overseas trip around that time I could certainly recommend the occasion and the venue as well worth noting in their diary.

This stay in Germany was made possible by the award of a Fellowship of the Alexander von Humboldt Foundation and the cooperation and support of Professor Dr. U. Gonser of the Universitat des Saarlandes. I also acknowledge the cooperation of the Department of Solid State Physics, Australian National University, and the Department of Physics, Faculty of Military Studies, University of New South Wales, Duntrune.

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THE AUTHOR

Dr. Stewart Campbell FAIP completed his Ph.D studies in experimental physics at Monash University in 1974 having earlier obtained his B.Sc. and M.Sc. at Aberdeen and Salford Universities. He then spent two years in industry as a designing engineer in cryogenics with Oxford Instruments before returning to Australia in 1976 as an ARGC Research Fellow at the University of New South Wales, Faculty of Military Studies. The three years at Duntrune were followed by four years as Research Fellow in The Department of Solid State Physics, ANU until his most recent six month period as an Alexander von Humboldt Research Fellow at the Universitat des Saarlandes in West Germany. Stewart, who has recently taken up a lecturership in physics at the University of NSW at Duntrune has published over sixty articles and attended numerous national and international meetings. His publications are mainly in the area of solid state physics and materials science as investigated by techniques such as Mössbauer spectroscopy, NMR, neutron polarisation analysis and bulk magnetic and specific heat measurements. His recent interests are centred on the study of amorphous materials and “hydrogen in metals” systems.

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Sunrise Industries

PRIORITY AREAS FOR THE ("SUNRISE") INDUSTRIES FOR THE 1980s

From: ALP Science & Technology Policy 1983

The following areas, in our present state of knowledge, seem likely to have the best prospects of success and can be discussed with some confidence. The list should, however, not be regarded as exhaustive. Some areas not on the list may well emerge unexpectedly, as has often been the case in the past. All should be considerable wealth generators.

1. BIOTECHNOLOGY. Australia has a very strong skill base in agricultural science, animal and plant genetics, microbiology and biochemistry. Biotechnology has good prospects of being the greatest industrial growth area of the 1980s, even more important than micro-electronics was in the 1970s. With appropriate stimuli Australia could emerge as one of the world leaders in this field, provided that we act quickly. It is suggested that funding be made available for investment (and equity participation) in biotechnology enterprises through the new Australian Industries Development Bank, and through the investment powers to be given to the Industrial Research and Development Incentives Board. Government assistance would be desirable in marketing analysis and in overseas promotion. The most promising areas for development are:

- Pesticides; weedicides (CSIRO has a C4 weedicide, with enormous potential);
- immunogenetics (sera have been developed to ensure that lambs are born in pairs — vital to replenish flocks after drought);
- diagnostic sera;
- monoclonal antibodies (techniques for highly specific self-medication, comparable to the use of insulin by diabetics);
- salt-resistant plants;
- plants requiring little water;
- nitrogen-fixing plants; and
- conversion of wastes into animal feed.

2. PERSONAL COMPUTERS. It seems likely that by the year 1990 most Australian homes will have a personal computer. Although unit costs will be low, this is an area we cannot stay out of, given the volume of anticipated demand for minis and micros.

3. COMPUTER SOFTWARE. This is far more labor-intensive than making computer hardware and there is an enormous demand, both actual and potential, throughout the Pacific Basin. We have a major advantage because most software is written in Latin characters, either in English or computer language (e.g. FORTRAN), and Japan is not a major exporter.

4. CUSTOM-MADE COMPUTER CHIPS. The work of CSIRO's Craig Mudge in Adelaide, with VLSI chips, and Prof Graham Rigby of the University of NSW, with LSI chips, should be encouraged.

5. SCIENTIFIC INSTRUMENTATION. This is a multi-billion dollar industry throughout the world and Australia has a good reputation. Many great opportunities have been lost in the past for expanding this area. The Interscan aircraft guidance system was designed here. Sir Allan Walsh's atomic absorption spectrophotometer is used throughout the world. In 1981-82 we imported $360 million of scientific instruments and exported only $86.6 million. The Starlab project can put us in the forefront of super-sophisticated scientific instrumentation for decades, e.g. the photon counter.

6. MEDICAL TECHNOLOGIES. We have made some spectacular advances here — e.g. the bionic ear and pacemakers (where we already have 20 per cent of the world market). In some areas, e.g. cell sorters, we have fallen behind, to the extent of three orders of magnitude: this undercuts the quality of our medical research.

7. LASERS. We import far fewer lasers (less than 0.1 per cent of our capital equipment bill in 1981-82) because we have a pre-laser industrial base. A comparatively small investment would enable Australia to generate its own laser developments.

8. COMMUNICATION TECHNOLOGY. We are moving towards a wired-society where many services will be provided by "dedicated" on-line services, using laser stimulated optical fibre. This is an area for urgent development.

9. INDUSTRIAL CERAMICS. CSIRO has developed a ceramic which has superior performance standards to metals under intense heat and stress, e.g. car and aircraft engines, cutting tools, grinders, artificial hips. The ceramic is called PSZ (partially stabilised zirconia), derived from zirconia sands, and will be a major world commodity by the 1990s.

10. SOLAR TECHNOLOGY. Prof Dick Collins of Sydney University, has produced vacuum-tube solar-heat collectors (with a selective surface of stainless steel + carbon on the inner tube), generating temperatures of up to 300°C — i.e. enough for low-grade industrial heat. This has been funded by Saudi Arabia ($5 million) and the NSW Government ($1.8 million). The tubes are fabricated in Japan because we lack the technical capacity to make them in high volume. Solar energy (silicon) cells, developed at the University of New South Wales at a cost of some hundreds of thousands of dollars, have an output 50 per cent higher than the cells used by NASA.

11. SHAPE MEMORY ALLOYS. Some alloys, e.g. Nitinol (nickel + titanium), are intensely sensitive to minor variations in heat and can be used in a variety of very sophisticated applications, e.g. microsurgery, space equipment, artificial hearts, dental prosthetics. Australia is rich in these metals.

12. FUSION. In the long term this is the best alternative to nuclear fission as an energy source on a large scale. Some work is being done on it in Sydney and Canberra at low cost. It is worth providing more research funds.

13. ROBOTS. This is a touchy subject, particularly for robots are likely to decimate employment in some areas of manufacturing, but it is an area with great potential, especially in doing dirty, exhausting and dangerous work. There may be some export potential, and we must consider the implications.
14. INTERMEDIATE TECHNOLOGY PROJECTS. Many of the Lucas Aerospace Shop Stewards Corporate Plan ideas are available for anyone who wants to make use of them. They are labour intensive and do not depend on high levels of skill. All fulfil major human needs, e.g. the Hobcraft for disabled children, the "telechiric" (hands at a distance) devices to enable workers to use and develop personal skills in controlling sensitive and dangerous processes, low-cost heat pumps, and equipment for the Third World.

15. HYDROGEN GENERATION AND STORAGE. A number of techniques are being developed — both through electrolysis and biological means — to use sunlight to extract hydrogen from water at a cost low enough to be competitive with fossil fuels.

16. BIOMASS. This has good potential as a fuel extender and could be a significant employer in North Queensland.

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LASER AND PARTICLE BEAM WEAPONS FOR SPACE WARFARE

D.R. Hutton, Physics Department, Monash University

Particle and Laser Beams, for long part of science fiction warfare, are now being seriously proposed as real world weapons. Systems design and basic research are well under way as is extensive planning for development, testing and ultimate deployment. Just what are these weapons systems and what demands are going to be put on physicists and engineers to meet the military needs? This short article attempts to answer these questions.

Proposals span all branches of modern warfare, both within and outside the atmosphere (AWST, 1980). Although the development of endoatmospheric applications are well advanced in such areas as defence against antiaircraft and antiantisk missiles, it is the exoatmospheric applications which have attracted most recent interest and attention from the public, including many physicists. These applications well and truly take the arms race into space. Perhaps they too offer defence against that much feared weapon, the nuclear armed ballistic missile.

Although space has become increasingly militarised over the last 15 years with systems aloft for military communications, command, navigation and surveillance, direct weapons applications have been avoided with the possible exceptions of co-orbital intercept killer satellites and the occasional blinding mission. Thus the new proposals for space based weapons are of great concern since they go against the intent of the 1967 Outer Space Treaty as well as the provisions of the 1972 Anti Ballistic Missile Treaty.

Laser Ballistic Missile Defence

Ballistic missiles are most fragile during the first 400 second powered section of their flight, when the absorption of 1 kJ cm$^{-2}$, received either continuously or in several pulses, breaches holes in their aluminium tanks by melting or cracking them. Since many hundreds of such missiles can be launched simultaneously from land based silos and sea based submarines in any of the world's oceans, a beam ballistic missile defence (BMD) system would need to cover the whole globe continuously, either from self-contained battle-stations or from relay mirrors receiving their beams from the ground. Each space based battle-station would need to have a power supply, a laser, wave front adaptive optics including a beam expander and a beam directing mirror. The number of battle stations required depends on the altitude and the effective range of the beams and can vary from 2 or 3 at synchronous altitudes (36,000 km) to larger numbers at lower altitudes closer to the boosters that are to be destroyed.

A minimum requirement for defence against today's missiles has been established (AWST, 1980; Hecht, 1982) to be about 20 battle-stations, with 6 in each of 3 polar orbit rings 2000 km high, and each with a 5 MW laser and 4 meter diameter optics. These would be capable of delivering 1 kJ cm$^{-2}$ at ranges up to 3000 km.

However, it is relatively simple to harden target missiles against radiation (Tsipis, 1981) by spinning them or by using highly polished retroreflecting surfaces or by using surface ablative materials, a complete system capable of handling a high density threat from missiles hardened against lasers to 10-20 kJ cm$^{-2}$ would typically need 100 battle-stations each with a 25 MW laser and 15 meter diameter optics. Comparison of these needs with present capabilities shows that there is obviously plenty of room for much research and development work in lasers and optics!

Some of the high energy lasers proposed (Tsipis, 1981) are indicated in Table 1, with many of them being actively researched in fusion energy programmes.

<table>
<thead>
<tr>
<th>Class</th>
<th>Wavelength</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Dynamic</td>
<td>10 μμμ</td>
<td>CO$_2$ (10.6)</td>
</tr>
<tr>
<td>Chemical</td>
<td>1 μμμ</td>
<td>CO (5)</td>
</tr>
<tr>
<td></td>
<td>1 μμμ</td>
<td>DF (3.8)</td>
</tr>
<tr>
<td></td>
<td>1 μμμ</td>
<td>HF (2.1)</td>
</tr>
<tr>
<td>Electron discharge</td>
<td>1 μμμ</td>
<td>Vis</td>
</tr>
<tr>
<td></td>
<td>1 μμμ</td>
<td>UV Rare gas Halogen</td>
</tr>
<tr>
<td>Free electron</td>
<td>0.1 μμμ</td>
<td>X-ray</td>
</tr>
<tr>
<td>Excimer</td>
<td>0.01 μμμ</td>
<td></td>
</tr>
</tbody>
</table>

In addition each battle station would need many control systems to sense launch and acquire the target, latch on with fast response, continuously track accurately (to ~0.2 micro radians) and dwell without jitter so as not to spread the beam over the target. And some aiming lead would be required since even at the speed of light the beam would take 3s second to travel 3000 km and during that time the target would have moved about 40 m. Systems would also be needed for kill verification and communication and command with military headquarters. Obviously each battle station would be a huge complex structure, and as such would be open to many military counter-measures including jamming, killer satellites and missiles.

To help handle multiple missiles launches the nuclear X-ray battle station has been proposed (Hecht, 1981).

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This would derive its energy from a once only nuclear explosion (~ 40 Kt) from which X rays would pump either 50 different UV lasers, e.g. hot electron excitation of rare gas halides, or X ray lasers (λ = 1.4 nm) each of which would have been pre-aligned with a target booster. Target destruction would occur by shock wave impulse from the hundreds of terawatt nanosecond pulses with the radiation creating, spallation or punching a hole, and thus defeating the now ineffective optical counters of spinning, retroreflection and ablative materials. Of course, in this case the battle-station would itself be destroyed, milliseconds after the laser pulse had left, by the following detonation debris.

Antisatellite Warfare

Many other missions have been proposed for space based laser battle-stations including targeting high flying aircraft such as those for AWACS, airborne and airlift and also satellites. Many satellites are very soft, with functions relying on sensitive detectors, complex electronics and solar cell arrays. Even a beam 10 times the irradiance of the sun (0.1 J sec⁻¹ cm⁻²) can cause overheating and damage to electronic systems. Thus it has been suggested that 5 battle-stations of 0.2 MW, 3 meter aperture would allow the achievement of space superiority in time of war by attacks on all satellites from low flying to synchronous altitudes. And, since of course, satellites might now be attacked by space mines and miniature homing vehicles, satellite defence has also been proposed as a role for laser beams (2 MW, 4 m aperture needed), so that the claims that the arms race is moving into space certainly seem to be increasingly plausible (Garwin, 1981).

Particle Beam Weapons in Space

High energy particle beams carry a large kinetic energy at very high velocities and can also melt and fracture materials, and thus their properties are under active investigation within not only the fusion programmes but also with weapons applications in mind. Charged particle beams (CPB) are inappropriate for use in space (Garwin, 1978) because of beam spreading produced by mutual electric repulsion and bending produced by the earth's magnetic field. Thus their use as weapons has been confined to short range within the atmosphere. Here the passage of high energy particles, e.g. electrons, creates a hot, low density, conducting channel that shortes out the mutually repelling electric fields, leaving dominant the weaker magnetic field, created by the moving charged particles. This magnetic field has a pinching effect on the beam, thus keeping it from spreading. Thus it might be that a beam of particles of energy 500 MeV, a current of 5000 amperes, a pulse duration of 100 ns and a repetition rate of 10,000 pulses per second could be effective against cruise missiles and ballistic missile re-entry vehicles at a range of up to 1 km, if indeed such a beam propagates over this distance without magnetic and control instabilities. Much present research is investigating beam propagation and beam target interactions using 5-50 MeV accelerators as sources.

For space use a neutral hydrogen atom beam has been suggested, obtained by initially accelerating a beam of H+ ions with a radio frequency quadrupole (RFQ) generator, aiming it with magnets and then stripping the excess electron by passing the beam through a rarified gas. Such a neutral hydrogen beam would not suffer from repulsive spreading or magnetic field bending but would however diverge by microradians due to the transverse momentum transferred during the stripping process (Parmentola and Tsipis, 1979). Thus a beam of 500 MeV, 10 ampere, 0.1 second pulses with several pulses per second might deliver 5 kJ cm⁻² to a ballistic missile booster target 3000 km away from a battle-station deployed similarly to the laser stations discussed above. Support systems would similarly be needed for target detection, identification, pointing, tracking, damage assessment, communication and command. The power supply would need to be of gigawatt capacity and might perhaps be based on high explosive magnetic generators or rocket driven generators.

Although it seems possible in principle to generate particle beams for weapons, the technical difficulties to be overcome are immense, and whether or not the weapons would be militarily and cost effective is yet to be determined (Kaplan, 1983).

Some Concluding Thoughts

Since both particle beam and laser beam battle-stations would need to be deployed within line of sight of enemy territory even in peace time it should be relatively easy to develop counter measures which would nullify their operation. Co-orbital satellites might be employed and communications and control links, and optical and radar tracking stations might be jammed. Neutral hydrogen beams can be further stripped of their remaining electrons to form easily dispersed proton beams by a small amount of air, perhaps injected between the accelerator and the target by a high altitude nuclear explosion. Laser beams are certainly already regarded as constituting a threat to satellites, and consequently some sensitive military satellites have been radiation hardened.

Although it might seem, from present day perspectives, that the space based weaponry discussed in this article is faced with tremendous development and deployment difficulties, the recent political decisions to direct a comprehensive and intensive effort to their development will mean increased funding and research direction towards high power lasers, large scale optics, beam propagation physics, radiation effects of materials, and the development of pointing and tracking devices and systems. Many physicists will therefore be directly involved. The majority of us, not working in these fields, will however need accurate information from our colleagues if we are to help as physicists in its evaluation. We will then be able to develop our own views, or be involved in the debates that will no doubt occur over this future, physics based escalation of the arms race.

Further reading

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Particle Beam Weapons.

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The Australian Physicist, Vol. 20, September 1983 — Page 202
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U.S. to develop nuclear space power unit

Three U.S. agencies are to co-operate in the development of a nuclear space power generation system required for spaceborne radars and directed-energy weapons. NASA, the Energy Department, and the Defense Advanced Research Projects Agency are hoping to achieve a ground demonstration by 1989 and an in-orbit 100 KW unit by 1995.

Aviation Week (21 Feb 1983) says that chemical lasers are the earliest candidates for use in space, and these do not require large amounts of electric power. However, shorter wavelength 'excimer' lasers offer important advantages, and these require hundreds of kilowatts of power. DARPA is currently developing potential spaceborne laser technology, particle-beam weapons and spaceborne radar techniques. By the 21st century, such systems could require tens of megawatts of electric power.

Kuiper flying observatory

The Department of Science and Technology coordinated the visit of NASA's flying infrared telescope, the Kuiper Airborne Observatory, which is undertaking seven weeks of astronomy research in the Southern Hemisphere.

The observatory is housed in a Lockheed C-141A transport plane, and consists of a 91 cm diameter reflecting telescope lens, together with its associated control and computer equipment.

During its stay in Australia the plane was based at Richmond RAAF Base. Two Australian and seven American observers, with their respective research teams, were involved in the flights, in May and June.

This is the second working trip to Australia for the NASA facility. In March 1977, the unexpected discovery of a ring system around Uranus (the seventh planet from the sun in our solar system) focused world attention on this unique world class telescope and the astronomers who use it.

The telescope makes observations mainly in the infrared region of the electromagnetic spectrum, between the visible and the radio wavelengths. Most of the infrared radiation from celestial objects cannot be observed at the earth's surface because it is absorbed by the atmosphere. Water vapour makes the lowest eight miles of air particularly opaque.

The Kuiper Airborne Observatory is above 99 per cent of the obscuring water vapor when it flies at altitudes of 12 to 13.4 km (39,000 to 45,000 ft). In the winter, those altitudes are in the lower part of the stratosphere at mid and high latitudes.

Studying the infrared radiation from celestial objects has given astronomers much new information about how stars are formed out of gas and dust clouds in space and how stars decay in their old age.

Because understanding astrophysical phenomena often requires an astronomer to obtain data at several different wavelengths there is a synergism between the KAO and many other observatories. For example, several ground-based radio astronomers use the KAO to get date at shorter wavelengths in the submillimeter region. Still others use both the KAO and the joint NASA/UK International Ultraviolet Explorer (IUE) satellite to obtain relevant data. Many astronomers complement their airborne work with an observing program at the NASA Infrared Telescope Facility (IRTF) on Mauna Kea in Hawaii.

Dr. James Elliot, from the Massachusetts Institute of Technology, the planetary astronomer whose team discovered the Uranus rings, looked for a ring system around Neptune (the 8th planet) as well as measuring its diameter and ellipticity by very carefully timing and measuring the characteristics of starlight as Neptune moves between the Earth and a bright star. This is one of the infrequent times when the C-141/KAO is used for visible observations. The event to be observed, on occultation, is visible only for a couple of hours in a limited region of the Southern Hemisphere. The airborne telescope was flown to the optimum point for these observations.

Dr. Harvey Moseley, from the NASA/Goddard Space Flight Center, also observed Neptune and Uranus in an effort to understand why Neptune has an internal heat source (radiates more than twice the absorbed solar flux) while Uranus apparently re-radiates only about the same energy it receives from the sun.

Dr. Al Harper, Jr., from the University of Chicago's Yerkes Observatory, conducted detailed observations of several galaxies which do not have counterparts easily accessible from the Northern Hemisphere. His experiment is particularly well suited to source mapping at several wavelengths.

Dr. Charles Townes from the University of California at Berkeley shared his high resolution scanning spectrometer with Dr John Storey of the University of New South Wales, Australia, and with Dr Michael Werner from the NASA Ames Research Center. Their research involves measuring intensities of wavelengths being emitted from ions and molecules; that data gives information about the electron density, the gas temperature, and abundance of each atomic species in and around distant astronomical objects.

Dr. Paul Harvey of the University of Texas at Austin has an infrared array photometer, which is used also by Dr. A.P. Hyland, Mt Stromlo and Siding Spring Observatories, the Australian National University, and Dr. Martin Cohen of the NASA Ames Research Center. They study the temperature and density conditions in the clouds of gas and dust around certain stars. The NASA C-141 Kuiper Airborne Observatory is based at NASA's Ames Research Center, Moffett Field, California, about 64 km (40 miles) south of San Francisco. It conducts 65 to 80 astronomy research flights a year on a routine, year-round schedule.

BRANCH NEWS
N.S.W. Branch
N.S.W. Physicists 'Get Physical'

Last December the N.S.W. Branch of the A.I.P. held their annual dinner aboard the Turrumburra, cruising the Lane Cove River. The weather, initially uncertain, turned out calm and mild and ideally suited to the occasion.
Food, wine, music, scenery and company all combined to create a memorable atmosphere and the evening was voted the most successful end of year function for many years.

Talks Programme

The Branch commenced its 1983 programme of monthly meetings on March 9th at the National Measurement Laboratory with a lecture by Dr Noel Barton, from the C.S.I.R.O. Division of Mathematics and Statistics, on the mechanics of the flight of a cricket ball. The theory of the transverse swing which capable bowlers can impart to the ball was discussed with reference to high Reynolds number fluid mechanics. Many illustrations of the air flow around a sphere for different values of the Reynolds number showed how the swing of the ball is caused by pressure differences on each side, due to asymmetrical boundary layer separation. This asymmetry can be produced by spin (the Magnus effect) which is isotropic, or by the bowler using the ball as an anisotropic sphere due to the presence of the stitched seam, which sticks out sufficiently to trip the boundary layer on that side. The need to keep the smooth side of the ball very smooth justifies the bowlers' habit of polishing up the ball whenever possible. The many cricket enthusiasts in the audience provided a lively question time after a most informative and entertaining talk, which should obviously be followed up by some appropriate field work on the Navier Stokes equation.

On April 12th, at the New South Wales Institute of Technology, Dr David Stephenson, Schmidt Fellow in Space Physics at the University of Newcastle, instructed and entertained an audience which included many high school students with his lecture on the search for extraterrestrial intelligence. Dr Stephenson stressed that his aim was not to answer the question, "are we alone in the Universe" but to outline the techniques which are used to try to detect the type of signals which might be expected from other water based life forms.

As aficionados of science fiction are aware, Mars has long been considered a favoured site for finding 'other beings'. However estimates of the possible number of other intelligent civilisations in the galaxy, or at least of earth like planets where they might evolve, range from 5 to 6 to over 10^9, depending on the background of the astronomer, novelist, mathematician etc. of those making the estimates.

The earth is the only known source of microwave signals in the Universe. The intensity of radiation is increasing by an order of magnitude every decade, so that we have only about twenty years to conduct the search for incoming intelligent signals before the level of background radiation from earth renders their detection impossible, at least by receivers on the earth's surface.

The failure so far of investigators on earth to detect an apparently intelligent signal could indicate superintelligence rather than the absence of intelligence. The search is being conducted in the frequency range 1-100 gigahertz.

Intelligent signals have specific characteristics; they are organised, with a narrow frequency range and a characteristic "whistle", whereas natural signals have no structure.

It is also possible that other civilisations could be detected, not by their transmissions of deliberate messages, but by evidence of activity, such as civil engineering structures, or normal working communications transmitters.

Future searches could utilise large telescopes orbiting the earth, shielded from earth's background radiation, to detect any incoming signals. Dr Stephenson concluded by stressing that conventional space travel is possible now, provided that voyages last more than a generation, and that cost, not lack of technology, is the limiting factor in the construction of suitable space ships.

The Branch was fortunate in being able to have Professor Arnold Arons, from the University of Washington, Seattle as a speaker, at the N.S.W. Institute of Technology on April 19th.

The need to encourage students to develop hypothetical deductive reasoning ability was the subject of Professor Arons' talk. This type of intellectual development is important, not only for the study of science, but has a role in general education by helping to give experience in this type of thinking, which can be easier in elementary scientific areas, than in social types of problems.

Professor Arons outlined some of the methods he uses in his own Physics courses to develop abstract reasoning capacity and to encourage the development of 'physical thinking'. To help dispel the confusion regarding acceleration and velocity, displacement and velocity, and many aspects of forces experienced by so many common students, exercises are included in lectures and also in test papers, which has been found to be by far the most effective way of convincing students of the value of such exercises in increasing their understanding of these concepts.

Unfortunately the demands of syllabuses in most New South Wales institutions limit the efforts of physics teachers to follow such a procedure, but the many questions from the small but interested audience confirmed that physics teachers here encounter the same problems as their counterparts in the United States.

The May meeting was held in conjunction with the University of New South Wales, when Professor Nicolaas Bloembergen presented the Dirac Lecture on the subject of Non Linear Optics and Spectroscopy. This field arose as a consequence of the development of the laser, which can provide a power density of 10^10 W cm^-2 in a mode locked pulse, (10^9 W is the total installed capacity of electrical generators on this planet) with peak electric fields of 10^8 volts cm^-1. If such a light pulse is put into a sample 'all hell breaks loose'. At lower power densities a wide range of non-linear phenomena is observed, and in his talk Professor Bloembergen discussed his close association with the investigation of many of these phenomena.

The recent explosive growth in the area of non-linear spectroscopy, to which the professor has made a significant contribution, was made possible by the development of the tunable high power dye laser. In the simplest non-linear spectroscopy experiments a laser is used to 'eat a hole' in the velocity distribution of the atoms in the sample under investigation. This technique gives a spectral resolution approximately 10 times sharper than the Doppler broadened spectral line profile. Such high resolution spectroscopy has permitted the recent adop-
tion of a length standard based on a specified value for the velocity of light. Other developments in non linear spectroscopy include two-photon absorption, in which Doppler effects are overcome by exciting a transition through the simultaneous absorption of a pair of oppositely directed photons, of a total energy equal to the transition energy; four-wave mixing separation, and the exploitation of the anomalous dispersal of far ultraviolet radiation from a visible laser beam. Professor Bloembergen concluded his talk with the comment that this field is one 'in which theory, experiment and application are merged together in one colourful aspect of Science'.

On Tuesday, June 14th at Sydney University Dr. Jim McCaughan, of the School of Physics gave an entertaining lecture on gyroscopic motion to an enthusiastic audience including H.S.C. Physics students. The aim of the talk was to give a physical, rather than a formal mathematical, explanation of precessional motion, and to illustrate some of the situations which arise as a consequence of this type of motion. While both mathematical and physical explanations are necessary for understanding, most modern textbooks concentrate on the mathematical at the expense of the physical.

The lecture started with an array of the type of demonstrations which appeal to students of all ages - the unmanageable suitcase (containing a heavy fast spinning disc), the bicycle wheel on a shaft, small rotors from artificial horizons and a large gyroscope whose rotation was maintained by compressed air directed onto vanes on the axle. An H.S.C student was easily persuaded to assist in the demonstration of conservation of angular momentum using a rotating chair and heavy masses which were moved towards and away from the axis of rotation.

Dr McCaughan then showed that 'free' gyroscopic precession can take place without any permanent external torque. When the gyroscope is properly counterbalanced an impulse downwards on the rotating wheel produces a conical movement of the rotating axis. If the gyroscope is then adjusted so that the wheel end is heavier, an impulse downwards on the wheel gives a combination of 'free' precession and ordinary 'forced' precession. Eventually the 'free' precession dies out and 'forced' precession only is left.

Nutation, the 'wobble' of the axis of a precessing gyroscope, is therefore free precession superimposed on forced precession. Applying a torque about a vertical axis, i.e. hurrying the precession, has the effect of raising the centre of gravity so that the wheel end of the axle rises. Diagrams of rotating discs divided into quadrants were used to establish that, in the act of precessing, a torque is generated which opposes the original applied torque. This generated torque goes on increasing until the gyroscope is precessing so fast that it can arrest the downwards motion of the wheel and bring it up to a plane. The axis therefore nutates.

Dr McCaughan concluded with demonstrations of thumb tacks and small stops 'sleeping', i.e., rising to spin on their points. Friction between the point and the surface on which the top is spinning acts to provide a torque about a vertical axis and hurry the precession so that the centre of mass is as high as possible.

At the University of New South Wales, on July 12th, Professor Trevor Cole, from the School of Electrical Engineering at Sydney, shared with a keenly interested audience his views on the future impact on our society of current developments in microelectronics and photonics (circuits based on photons).

Communications systems, both on a world wide and an individual level, are becoming, essentially, computing systems. Recent developments in microelectronics have been towards reduced size and increased density. At present, the circuit lines have reduced to 5μm in thickness and the circuits are beyond easy comprehension or the capacity of a single design engineer. The necessity of handling this complexity has led to the increased use of computing power. By the turn of the century, the physical scale will reach the level of human brain wiring, getting up to 20,000 bits of information on a single chip and the cost per unit will drop dramatically.

Professor Cole also discussed some of the developments in optical fibre communications. Some of the modern ultrapure glass materials allow transmission of 80% of the light through one kilometre of fibre. This is a considerable improvement over crystal glass, in which transmission was 80% over one centimetre. With the new materials, repeaters are necessary only about every 100 km, and many bandwidths can be transmitted at the same time.

Over the years 1850-1980 the growth in services available through the telephone system has been almost exponential. Communications are actually becoming cheaper and cheaper relatively but people are reluctant to use the systems, and most facilities are very underutilised. This is particularly true of telephone user links which represent just over half of Telecom's investment.

The present challenge is to develop technology which is accessible to everyone. This is the case with even very complex computing systems which can be accessed by personal contact through the telephone. Not every person who uses such facilities needs to learn to program computers! Professor Cole described a recent project of Infotelmatique, the French equivalent of Telecom, in which 2,000 premises, selected in random, had computer terminals installed to provide access to information services. Surveys are being conducted of the uses made of the facilities. An Electronic Directory is planned for this time when all telephone subscribers will have terminals and the printed directory will be discontinued.

Professor Cole concluded by stressing that Australia needs many more people with the skills to handle this new complex technology and therefore more students should be encouraged to study science and engineering, in line with countries such as the United States and Japan. The lack of interest in entrepreneurial skills which is evident in Australian companies could lead to this country being left behind by rapidly developing countries who are moving ahead in developing new technology and are not being held back by what the Professor called "traditions of the past".

Moira Welch

Victorian Branch

The May meeting of the Victorian Branch was addressed by Professor Graham Wiliams from the Department of Chemistry, University of Melbourne, and the subject was Liquid Crystalline Polymers, and we enjoyed an interesting account of a relatively new research field which can number among its credits the bullet-proof qualities of President Reagan's vest!

The existence of liquid crystal phases in low molecular weight compounds was recognized in the late nineteenth century, e.g., in esters of cholesterol, crystals on a rich melt sharply to form an opaque rather than an isotropic melt. It was deduced that some form of order still existed in the molten state; it is now known that the molecular structure of the liquid crystal phase is intermediate between three-dimensional solid state crystalline order and the disorder of the isotropic liquid state. The formation of the intermediate liquid crystalline phase (mesophase) requires the molecules to

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be long, rigid and strongly polar; attractive intermolecular forces may then impart some measure of long range order to the liquid structure.

The three main types of liquid crystal are shown schematically below. The centres of gravity of the molecules in smectic crystals have long range order, the molecules lying in planes with well-defined interlayer spacings which can be detected by x-ray diffraction. In the nematic phase, the centres of gravity of the molecules have no long range order, but their long axes tend to be aligned along a common axis. In the cholesteric phase, sometimes described as a twisted nematic, and found only in optically active molecules, there is again a preferred orientation of the long axes, but that orientation varies in a periodic fashion.

**SMECTIC**  **NEMATIC**  **CHOLESTERIC**

Liquid crystals adopt the shape of their containers, just like ordinary liquids, but they also exhibit anisotropic physical properties which are usually associated with solid crystals. These properties originate in the long range orientational order of the molecules, cooperative intermolecular forces making their electrooptical behaviour very different from that of ordinary liquids. Thus the electric field strengths required to cause significant changes in the optical properties of liquid crystals are orders of magnitude less than those required in ordinary liquids.

During the last ten years, considerable progress has been made in producing high-strength high-modulus organic polymer fibres. Allowing for their lower specific gravity, they can be regarded as stronger and stiffer than glass and steel, and are useful in providing reinforcement for rigid and flexible composites. Their high strength is believed to originate in the high load-bearing capacity of their fully extended polymer chains. They are spun from concentrated solutions in hydrogen-bonding or strong acid solvents, the solutions being anisotropic and probably possessing nematic liquid crystal properties. The anisotropy is indicated by a haze at rest and an opalescent appearance under low shear, inspection using a polarizing microscope showing birefringent regions. Extended chains are achieved because the liquid crystalline phase tends to orient under shear. Applications include use in tyres (belting), conveyor belts, body armour and structural parts of aircraft.

Many biological chain molecules, e.g. DNA, tobacco mosaic virus, and synthetic polypeptides, also form mesophases in concentrated solution. Polypeptide liquid crystals can be prepared simply by dissolving the polymer in a solvent which supports the α-helical conformation; the solution becomes liquid crystalline when the polymer concentration exceeds a certain threshold value. However, the homogeneous liquid crystalline phase is preceded by a biphase region in which both isotropic solution is in equilibrium with liquid crystalline solution, over a narrow range of polymer concentration. The liquid crystalline phase is readily recognized by its birefringent properties, and there is a very marked cusp in the plot of solution viscosity against concentration at the transition from isotropic solution to liquid crystal.

Professor Williams stretched our ability to recall elementary organic chemistry to its limits, and in my case far beyond, and in so doing indicated very unequivocally the benefits of interdisciplinary research in a field which had lain dormant for several decades.

The topics chosen by our speakers in the early part of 1982 showed, quite fortuitously, a strong solid state bias. However, our scientific palate was refreshed at our June meeting when we were addressed by Dr. Bob Frater, Chief of the C.S.I.R.O. Division of Radiophysics, on the topic “The Australia Telescope — A Meeting of Science and High Technology”.

The history of the proposal to construct an Australian synthesis radio telescope starts from the formation of a steering committee in 1975, representing all Australian astronomy groups. A design was evolved over the years, culminating in 1982 with a proposal which is being funded as a Bicentennial project. It is intended that 60 people will work full time on the project, in addition to many others involved in outside contracts. A committee representing interested Australian institutions and including three overseas advisors has been set up, a project office opened, and an antenna design consultant appointed.

The Australia Telescope (AT) will consist of the present array of six 22 m diameter antennas covering a 6 km baseline near Narrabri N.S.W., the Parkes 64 m telescope, and an antenna to be located on Siding Spring Mountain. These three sites will be linked by microwave radio, and an additional microwave link being installed by NASA between Parkes and Tidbinbilla on the fourth component into the system from time to time. The 6 km array near Narrabri offers 1 arc second resolution of 10 GHz, while the four sites together will allow 10 milliarc second resolution for the mapping of compact objects. The telescope will be required to operate with high efficiency up to 30 GHz, the central parts of the antennas being designed to reach 115 GHz. Simultaneous observation at two frequencies will be possible, a unique feature in a synthesis telescope. Possible research areas which could be addressed include the galactic centre, Magellanic clouds, molecular liquid crystal formation regions, quasar/galactic nuclei and galactic dynamics.

One of the most interesting aspects of the telescope is the design of its antennas. They are required to have excellent multifrequency performance from a few hundred MHz up to the frequencies indicated above, and changes of frequency should be almost instantaneous, and fairly easily achievable from a remote location; contrast this with earth stations operating at fixed frequencies, typically 4.6 or 12.14 GHz. Furthermore, the necessary pointing accuracy, some 11 arc seconds, is almost an order of magnitude better than that of earth station antennas. Clearly, these requirements are much more stringent than those of communications antennas which presently form almost the entire large antenna commercial market. A completely new design is required — a adaptation of an existing design would almost certainly prove inadequate.

One rather helpful difference between the AT antennas and those of earth stations is the reduced reliability level acceptable in the former. Since the economic penalty for down-time is not so large for the AT, the antennas need not be designed to operate in high wind conditions, and the facility of multifrequency operation allows switching to lower frequencies when weather conditions degrade performance in higher bands.

In concluding his talk, Dr. Frater emphasized that the AT is a large scientific project, judged on international standards. To undertake it, relying heavily on national technical skills and powers of innovation, is an act of faith in Australia and its future in the era of high technology.

Robert Fleming
Western Australia

The W.A. Branch was most fortunate this month, being able to enjoy two stimulating lectures by Sir Ernest Titterton. He was in Perth as a Council Member of the Australian Institute of Nuclear Science and Engineering, A.I.N.S.E., for their Annual General Meeting. His lecture to the A.I.P. was entitled "Wastes and Their Disposals - Particularly Radioactive" and the seminar to the U.W.A. Physics Department was called "The Future of Nuclear Physics". Sir Ernest's lectures, which are always very well prepared and elegantly delivered, provide much food for thought and are therefore entertaining even if one disagrees with some of his conclusions.

His "Waste Disposal" lecture opened with the provocative statement that he was surprised to see a wide belt of smog over the oceanic horizon outside Fremantle! This smog no doubt has been created by the enormous amount of general waste produced by a modern industrial society, namely 70.5 million tons of waste will be produced annually by 13 million people with an estimated annual increase of 5%. This waste has been composed of domestic refuse, industrial waste, sewage sludge and agricultural waste presenting a largely unsolved problem for the local authorities. Furthermore, modern society is based on the consumption of power, it is the waste generated by these power stations that he wished to discuss further. Of the four major primary fuels, coal, oil, gas and nuclear, coal fares by far the worst. The statistics show that coal fired power stations produce the greatest air pollution with many noxious gases including some radioactivity being released, chemical wastes including arsenic being formed, that they have the highest death and accident rate and a huge transport problem. Next on the demerit scale comes oil with gas having a very low demerit rating. He emphasised that Japan will want to burn gas in their power stations because of the low pollution problem associated with that fuel which no doubt will be a great boon for W.A. The rest of the lecture was spent in putting the nuclear fuel waste disposal problems in perspective with regard to the general waste disposal problems. Having stressed that the energy demands in the future would necessitate the use of nuclear fuel for the generation of power, he proceeded to analyse nuclear waste disposal through its various stages. It has been decided to leave all wastes in large ground cooling tanks for 50 years to enable the short half life isotopes to decay and allow the resulting enormous heat generation to subside. This represents the first stage. Above ground storage is not an overwhelming problem for a limited period of time as the actual physical quantity of waste generated is small, about 1/100000th in weight compared with coal for the same amount of energy released. He discussed the second stage, the encapsulating stage briefly, mentioning (a) vitrification of waste in glass surrounded by steel containers and (b) Synroc. The third stage, the ultimate disposal, he discussed at some length. His own preference appeared to be the burial of the steel canisters. A computer program simulating the possible contamination of the ocean and assuming a 1000 year Gaussian distribution of canister failure, calculated that the contamination of the ocean would yield the same order of magnitude and distribution of radioactivity as the present levels of natural distribution and contamination from weapons testing.

With regard to the $^{239}$Pu in the burnt out fuel, he pointed out its enormous value for further power generation and its high financial benefit as it is more expensive than gold. Under normal circumstances, reactor fuel lasts for 3 years and during that time sufficient other radioactive nuclei will be created to poison the extraction of the very fissionable $^{239}$Pu making it useless for military purposes. Only if the fuel elements are melted earlier, at about 1 year, can the $^{239}$Pu be extracted for military purposes. About this early melting he said "It is not on, it is illegal, you are not allowed by the international regulations of the I.A.E.A. to melt a reactor at this time, the fuel has to go a full cycle". This closed his discussion of this very difficult subject.

Unfortunately, this correspondent on her visit to the I.A.E.A. International City, Vienna, in September 1982 came away feeling that the huge bureaucracy of the I.A.E.A. would be quite unable, even incapable, of policing or enforcing such regulations, leaving the problem of the proliferation of $^{239}$Pu, as far as she is concerned, unsolved.

In the seminar to the Physics Department, which was not an A.I.P. function, Sir Ernest discussed in the main the state of the art of nuclear on cancerous. He showed what a relatively under-financed physics department in Australia might be able to build for two million dollars.

At A.N.U. it is proposed to build a tandem generator which will lift Canberra above the Coulomb barrier! The generator is designed on a modular basis of Cal. Tech. origin, where each resonator is made of copper. The resonators can be built in the University workshops making it economically feasible. When resonating at super-cooled temperatures, a clean beam with small spot size and good resolution should be obtainable. Perhaps more details will be forthcoming in this journal. We wish A.N.U. Nuclear Physics Department much success in their interesting venture.

The rest of the Branch's activities were devoted to the everlasting problems of physics teaching. A submission was made to Beazley Committee Enquiry into Education in Western Australia. A meeting introducing high school students to various branches of physics employment was organized at Murdoch University. The arrangements for the Annual Youth Lectures and the "Visit to the Country" lectures have crystallised.

G.H. Thompson

Letter

Dear Sir,

The "Call to halt the nuclear arms race", initiated by Prof. Runciman, is just plain silly. If they ever hear of it, it would only make the Russians smile.

Dr. H.H. Macey,
Floreat Park.

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BOOK REVIEWS


Reviewed by A.R. Williams, 10 Mansfield Ave, Carlingbah, N.S.W. 2229.

This symposium proceedings is a loose collection of papers on problems faced by “Quaternarists”, and some possible neontological solutions (those derived from a study of living organisms). The collection is so loose that a chapter on dating methods and Quaternary physical changes was added at the beginning to give the book a frame of reference and a chapter on Uniformitarianism and argument by analogy was added at the end to explain the underlying philosophy.

The relevance of a neontology-paleontology intercourse is variously apprehended. Three authors (Thorne, on hominid remains, Calaby, on animal dispersal and Wace, on neutralized species) state that their fields contribute nothing to the topic; Watts, on plant macrofossils, doubts there is much profit in such an intercourse; Franklin, on population genetics and Macfarlane, on tolerance limits in animals, both make the point that adaptation to climate is not necessarily reflected in the fossil remains, thus suggesting that when neontologists do talk to paleontologists it doesn’t help.

Nix, on tolerance limits in plants, is more optimistic, though admitting that explanation of the fossil data in terms of the modern data remains “a goal for the distant future”, and both he and Crisman, on aquatic invertebrates, make a plea for good modern data and a multivariate approach.

Part of the problem is due to inherent weaknesses in paleontological methods. Wells, on mammal fossils, admits to “piling assumption upon assumption”; Davis, on fossil pollen, and Smith, on vegetation dispersal, admit that vegetative changes can be due to species interactions (e.g. succession, especially in the interglacial periods) and thus have nothing to do with climatic change; Main, on ecophysiology, recognises that it “does not contribute much to the understanding of late Pleistocene extinction of the large marsupials”, but in the absence of anything better goes on to give an ecophysiological explanation for late Pleistocene extinction of the large marsupials.

In chapter 14 Rymer describes how paleontology is saved from the realm of fantasy and guesswork by the principle of Uniformitarianism (the basic laws of nature and types of possible processes remain the same through time). This philosophy was originally formulated to displace Creationism, which proposes supernatural origins and occasional supernatural intervention; Creationism argues from the Bible as an eye-witness account of history, whereas Uniformitarianism argues by analogy between past and present. My conclusion from reading this volume is that the analogy is thin.

The book is cheaply produced and the review nature of the material may make it useful in an undergraduate paleontology course where the theme is “proceed with caution” (or perhaps scepticism).

GEOMETRICAL METHODS OF MATHEMATICAL PHYSICS, B. Schutz, Cambridge Univ. Press, Cambridge, 1980, xii + 250pp., £7.50 (paper), £18.00 (hardcover).

Reviewed by J.R. Shepanski, School of Physics, The University of New South Wales.

In recent times, modern differential geometry has found important applications in fields as diverse as the General Theory of Relativity and the Elementary Particle Theory. A need has thus arisen for a book supplying introductory material for physicists wanting to understand the new developments but unfamiliar with the technical (geometrical) nomenclature and notation.

While some attempts have been made to fill this gap, they tend to lack in clarity (e.g. “Elementary General Relativity” by C. Clarke) or to assume the reader to be already familiar with some of the material (e.g. “Gravitational Curvature” by T. Frankel). Even the otherwise admirable and valuable, magnum opus by Misner, Thorne and Wheeler on “Gravitation”, while, naturally, a virtual “breeze-through” for more advanced readers, does present some difficulties for those in need of a clear and concise introduction.

The appearance, therefore, of the book here under review seems particularly timely. The author, a Reader in General Relativity at University College of Cardiff, in a freely flowing English (despite the jarring Americanised spelling “fiber” and “neighborhood”, out of place in a book published in the U.K.) and an easy style, carefully guides the reader through “some of the more important notions of twentieth-century differential geometry” — as he explains in the Preface. His stated object is to “teach mathematics, not physics” but his attention to concepts and basic threads of argument rather than to pedantic details will be refreshing and helpful to any interested physicist. Readers with more technical leanings are directed, by well-annotated bibliographies (one for each chapter), to appropriate, professional treatises, such as Choquet-Bruhat et al., “Analysis, Manifolds and Physics” and Spiwak’s four-volume work: “A Comprehensive Introduction to Differential Geometry”.

An average physicist will not find it necessary to peruse chapter 1 in full: a few glances to ensure familiarity with a number of simple definitions and with the notation will suffice. The remaining five chapters will require from him some more concentrated attention. Chapters 2 to 4 cover the theory of tensors defined on differentiable manifolds (including vectors and one-forms — i.e. the contravariant and co-variant vectors in the older nomenclature), Lie derivatives and groups and the general idea of differential forms. Concepts of fibre-bundles, representation of vectors by different operators, Killing vectors and other “goodies” are discussed in some detail. Chapter 5 deals with physical applications and the last chapter extends the subject to cover Riemannian manifolds and to trace out relation to gauge theories. The Appendix features solutions (or hints) to some of the many useful exercises scattered right throughout the text of this fascinating book.


Reviewed by H.C. Bolton, Department of Physics, Monash University.

This is the successor to the author’s book “A Random Walk in Science” (1973) which was reviewed by M.G. Bell in the AP (1976) 13, p. 88. It is a collection
of humour and anecdotes related to science, largely physics. Every professional subject has its myths, legends and folklore. As physics students, we were all brought up on them and if we become teachers we take them on to our own students. After-dinner speakers at conference dinners retell them and we repeat them over coffee when we get back to our laboratories. Of course, writing down the stories in a book makes them formalized and canonical but that must be seen to be inevitable with any subject with a literature and we all cannot have been members of the Post Prandial Society of Cavendish Laboratory. (Does it still exist?) At any rate, having these Random Walks on our library shelves, or better, on our own, enables us to verify the sources of the folklore of physics because the entries are well referenced. Until I read the Random Walks I had not realize just what were the sources and I suspect that many readers would have been like me. For example, I did not know that it was R.W. Wood, surely a prince of jokers, who sent his pussy cat through the tubes of his spectograph to clean them (p. 109). It was the Netherlands meteorologist Buys-Ballot (not Boys-Ballot) who in 1845 used an orchestra of trumpeters on a railway train to demonstrate the Doppler effect (p. 114); would a post-horn on a stage coach have revealed? I was glad to read what Pauli said to God (p. 77) though in the version that I had heard, Pauli got to Heaven on a Wednesday, in time for the regular weekly colloquium that God was giving that week's talk. I liked the sales letter announcing Error Bars (p. 76); "the cost per point increases quite rapidly as the error bar size decreases". I had no idea there was a law of the entropy of loose change in the pocket or purse; "the entropy of coins is inversely proportional to their denomination" (p. 119). Now that I have had this pointed out, it is self-evident. Did you know that a serious scientific article has a cat as co-author? (p. 110).

Some entries are serious and George Steiner's "Literacy in an age of technology" is a fine condensed piece of writing. I found the verse rather indifferent, even that written by scientific masters and to my mind, nothing in this line seems to compare with Flanders' and Swans "Second Law of Thermodynamics". However, I once (only once) played this in my thermodynamics class of undergraduates to a numbering silence. Kerr Grant's "(p. 117) but this does not detract from a good story about a lecture demonstration in Adelaide. I am sure new stories are being created at the present time; there cannot have been "giants only in the old days".

Random Walks is a book in which all physicists can find something of interest and there can't be many books published now of which this can be said. For this reason alone it is worth buying though in these days of restricted library budgets what will your chairman say to your next book request? Perhaps it will be better to buy it yourself or ask for it as a present. If you do, you will find yourself an authority on scientific folklore and will be able to face with equanimity the next request for a conference after-dinner talk.

Reviewed by J.J. Dunlop, School of Physics, The University of New South Wales.

Image enhancement techniques have been highly developed over the past 20 years and their application to such fields as geophysics, satellite mapping etc. is well known. The somewhat simpler application of one dimensional image enhancement for say spectrum enhancement has not enjoyed such publicity. This monograph by Blass and Halsey seeks to fill this gap and should be of interest to many physicists and physical scientists. When reading this book one must inevitably compare it with that classic of signal recovery "The Measurement of Power Spectra" by Blackman and Tukey (Dover 1958); in both cases the techniques are well established, albeit dispersed over a number of disciplines, and the authors' tasks have been to collate all unnecessary and side issues and to present a simplified version directed to a specific application. In this case the application is recovery of the original signal after it has pass through an instrumental system (filters), by the process of deconvolution ("inverse filtering").

The book begins in an easy and relaxed fashion, with the first four chapters being devoted to an introduction of the technique of deconvolution at an elementary level. It is discussed in the language of the physical scientist, the illustrations of technique application being to absorption spectra.

The practical application of the technique via computation algorithms follows and it is here that the authors' bias and preferences in choice of technique come to the fore. They settle for a modified version of the Jansson deconvolution algorithm (P.A. Jansson, J. Opt. Soc. Am 60 184 1970) which on the basis of their experience "is capable of producing consistently good results when properly applied". The algorithm is explained and its application illustrated on data generated to stimulate three different types of spectrum. A realistic application to an IR spectrum is provided in chapter 10 — "A complete case History of Deconvoluted Data Run". This, together with a listing of the necessary FORTRAN programs and advice on typical beginners problems, should enable the physical scientist with some computer experience to get the deconvolution technique up and going. However, the authors warn "nothing is cheap and deconvolution users can expect to invest a number of man hours and computer hours on the deconvolution technique".

The book is well written and presented. It is intended to provide a practical guide to the beginner of deconvolution techniques and contains numerous diagrams, illustrations and a useful list of references for further development.

Reviewed by J.M. Anderson, CSIRO Division of Plant Industry, Canberra.

Here is an excellent synopsis of the uses of ultrafast laser spectroscopy (10⁻¹³ to 10⁻⁹ sec) to probe primary events in photosynthesis, vision and more briefly in haemoproteins and DNA, together with a brief account of the measurement techniques. Following introductions of each biological process (invaluable for physicists, engineers or chemists), current progress in both experimental research and theoretical understanding of each primary process is presented by a number of experts in that area. For the first time readers may gain a complete overview of developments in each field, making this book useful not only for beginners, but for experts be they physicists, chemists, biologists or engineers. Professor Alfano has assembled a bright band of contributors and edited the 18 chapters carefully. This book should stimulate future research by those lucky enough to have the necessary equipment and suggest possibilities of collaborative research. Furthermore, being the only source to cover the exciting developments of pico-second technology in photosynthesis, vision, haemoglobin and DNA over the past ten years, it is recommended to libraries.

The Australian Physicalist, Vol. 20, September 1983 — Page 709
ADVANCES IN ELECTRONICS AND ELECTRONIC PHYSICS, VOLUME 57, C. Marton (Ed.), Academic Press, New York, 1981, x + 500pp., SUS67.00 Reviewed by B. Window, CSIRO Division of Applied Physics, Lindfield, NSW.

This review series continues in the tradition of relevance and excellence set by its numerous predecessors. The contributions are pitched at a level suited to the general reader, except for the first, entitled "Elementary Attachment and Detachment Processes II", by R.S. Berry and S. Leach, which covers this field in some depth. The review article on fibre optics in local area network applications, by D.C. Hanson, is a readable summary of problems and progress in this important technology, and the article on Surface Analysis using charged-particle beams, by P. Braun, F. Rudenauer and F.P. Viehböck, is a useful complete summary of the many contributions to this field. This latter article concentrates on elemental mapping of surfaces, and on the possible further developments like three-dimensional imaging through samples.

Of the remaining articles, this reviewer found the one by D. David on Microprocessor Systems eminently readable as an introduction to the field of microprocessor architecture, and the one by H. Redlein and R.J. Kelly on the new International Standards applicable to microwave landing systems rather dry but clearly well-written and complete. This is not the sort of book an individual would purchase in most instances, but for the institutional library, it is an excellent addition to this continuing series.

Physics Roundabout

Nuclear gaining ground

Data collected at the end of 1982 by the International Atomic Energy Agency show that the contribution of nuclear power to world electricity production is growing steadily, despite some cancellations of nuclear projects and the effects of the world recession. By the end of the year, 294 power reactors (with a total capacity of 173 108 MWe) were on line in national grids in 25 countries, with 215 under construction in 27 countries and 156 more planned. There were seven new orders, four in France and three in Japan. However, the year also saw 18 cancellation of ordered plant, two in Italy and the rest in the USA.

Finland now has the largest share of nuclear electricity generation for its power needs, with a 40.3% contribution (provisional figure); France comes second with 38.7%. Although cancellations have outnumbered new orders in the USA for the most of the past decade, nuclear energy is still expected to become the second largest contributor to American electricity supply (after coal) when the 1982 data are compiled. See p. 82 (April) for the situation at the end of 1981.

New Institute Group

The Council of The Institute of Physics has given approval to the formation of a new Group, the Instrument Science and Technology Group, under the chairmanship of Dr. K.C. Shotton of the National Physical Laboratory. The object of the Group is to provide a forum for the discussion of the science and technology of measuring instruments and measuring systems. It will be particularly concerned with the physical principles of sensors and transducers and their industrial applications.

The proposal to form the Group came from members of the Editorial Board of the Journal of Physics E: Scientific Instruments, and it is intended that the new Group will maintain close links with the journal.

Although most physicists use instruments of one kind or another and many become involved in instrument design, there is very often a gulf between the researchers who study the basic physical principles and measurement systems utilised in instrumentation, and the physicists and engineers who design the commercial instruments used routinely in laboratories and workshops. It is the intention of the new Group to take a lead in bridging that gap by promoting a broader awareness of new measurement technologies and encouraging their exploitation by instrument designers, manufacturers and users.

Details of membership of the Group are available from the Registrar, The Institute of Physics, 47 Belgrave Square, London SW1X 8QX.

Green-fingered jellyfish

Great shoals of yellow-green grapefruit-sized jellyfish migrate twice daily across the quiet surfaces of mysterious lakes on the tropical island of Patau.

They rotate slowly as they go, using eight primitive eyes on the edge of the bell to sense light and shade. The yellow fish are sunning the symbiotic algae in their tissues.

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The Australian Physicist, Vol. 20, September 1983 — Page 210
The lakes these jelly fish inhabit have stratified water. It is not ruffled by the wind or mixed by currents, for the lakes are deep sink holes dissolved in limestone which has been lifted above sea level by volcanic action.

On the top of each lake lies the layer of fresh water in which the jelly fish swim by day. Underneath are layers of brackish water coloured green and red by algae.

Down deep is an anoxic layer of salt water charged with hydrogen sulfide which reduces nitrogen compounds from dead organisms to ammonia.

By night the jelly fish sink down to the deep layer to pick up the nitrogen fertilizer needed by their algae. They have an astonishing capacity for absorbing ammonia — most other water creatures excrete it.

Many may not live by bread alone but these jelly fish live solely by cultivating their symbiotic algae. The pattern of their life is dictated by their need to grow their own food in the spartian environment.

Stinging cells and stomach are useless to them for there is no prey. Those organs have become attenuated.

How long did it take the jelly fish to perfect their gardening technique? How does the mechanism for absorbing ammonia work? Why do the jelly fish always rotate anticlockwise?

The answers to these questions will throw light on our understanding of evolution as well as symbiosis. — Biology in Action

CSIRO facilities for technology artists

Complex high technology equipment at a CSIRO laboratory in Sydney is to be made available to allow artists to experiment with the application of technology to their art.

The Australia Council and the Australian Film Commission are providing funds for up to three artists, creative film-makers and technicians, to work in residence at the Division of Applied Physics at Linfield in Sydney.

The Division has a wide range of mechanical and optical equipment used in its research related to industry and the community.

Announcing CSIRO's cooperation in the new venture, the Chief of the Division of Applied Physics, Dr John Lowke, said each individual would spend up to three months fulltime residence in the 12-month period beginning in September.

"A living allowance of up to $8,000 per artist is being made available by the Australia Council and the Australian Film Commission," Dr Lowke said.

He explained that the Division had facilities in a range of modern technologies including computer-controlled machining, computer graphics, electroplating, photo engraving and laser machining, as well as a fully equipped photographic laboratory.

Dr Lowke said he was enthusiastic about the involvement of the Division in the "artist in residence" scheme.

He said the artists would be working with his staff of 400 researchers who were highly skilled in the use of the new high technology equipment.

Dr Lowke said he believed many people were unaware of the influence of technology on the arts. He likened the present developments in computer art to the revolution in popular music which occurred in the 1950s following the development of the electric guitar.

"Most people believe that the introduction of rock and roll music was initiated by Bill Haley singing 'rock around the clock.'"

"However it was really due to the application of new technology to the production of music.

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“In particular, it was due to the invention of the electric guitar,” Dr Lowke said.

“For the first time it was possible to produce music and rhythm at such an intensity that it could shake the body of the listener,” he added.

“Ear splitting volumes with completely new sounds could be combined to make possible new modes of artistic expression.”

“These days we have computer music and electronic music using a wide range of instrumentation,” Dr Lowke said.

“Computer graphics makes possible new forms of pattern and symmetry so that whole art exhibitions are devoted to work produced using computers.

“Holography has introduced new potential to make images in three dimensions and computer-controlled machines have made possible the cutting of metal in complex configurations and shapes which previously were almost inconceivable.

“As well, we have lasers, glassy metals, and even the possibility of laser sculpture with these new materials,” Dr Lowke said.

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Technology summit announced

The Minister for Science and Technology, Mr Barry Jones, has announced that a National Technology Summit will be held in Canberra between 26 and 28 September.

Mr Jones announced the conference during an address to a meeting of State and Federal Industry and Technology Ministers in Perth which he and Senator Button attended. This was the first Commonwealth/State meeting where Ministers responsible for industry and technology had met to discuss common issues.

The objective of the September conference will be to achieve a consensus on the courses of action necessary to implement the Government’s technology oriented policies, and priorities for the development of industry, as part of the Government’s overall strategy for economic recovery.

Mr Jones said that the recent Espie Report on finance for high technology industry had concluded that no country had succeeded in establishing a climate for investment in high technology without the Government taking positive action and, at a minimum, adopting a catalytic role.

Mr Jones pointed to the need for Government involvement, for State and Federal Government cooperation and for a greater commitment to R & D by manufacturers. He highlighted the need to recognise the contribution of R & D to industry’s development and to focus effort into three areas:

— the emerging high technology (sunset) industries set out in the Government’s election policy,
— making traditional industries more efficient and arresting their decline through the adoption of new technology, and
— the provision of a scientific and technological infrastructure for the development and diffusion of new technologies to assist the growth of new industries.

Mr Jones put the case for a national approach saying bluntly “We need to get our act together, and determine how cooperation will take place and not whether it is necessary”.

Attendance at the Conference would be by invitation and the Prime Minister, the Minister for Industry and Commerce, the Minister for Employment and Industrial Relations and the Minister for Education would be invited to address the participants. The 120 invited participants would also include State Government Technology Ministers and senior executives from financial institutions, large manufacturing companies and small high technology enterprises, representatives of the trade union movement, academia, industry and professional associations, and CSIRO.

The Government was considering several initiatives in the Budget context, as part of normal policy review processes and as a response to recent reports such as that of Sir Frank Espe. Issues currently under consideration included venture capital, support for specific industries such as biotechnology and microelectronics, amendments to the Industrial Research and Development Incentives Scheme and procurement policy.

Mr Jones described the forthcoming conference as a continuation of the policy of cooperative Federalism the foundations of which had been laid at the National Economic Summit earlier this year.

“The National Technology Summit is seeking the same goals. We need to plan together, work together and seek a high level of cooperation in the struggle to build a healthy economy”, the Minister said.

Commonwealth Scholarship and Fellowship plan

Australian-European Awards program

Submissions are invited from educational Institutions and organisations seeking to nominate distinguished overseas scholars and educationists to visit Australia under the above schemes in 1984/85. A small number of Visiting Fellowships is available under the Commonwealth Scholarship and Fellowship Plan for experts from Commonwealth countries, and under the Australian-European Awards Program for experts from European countries.

The awards are intended to provide opportunities for Australians to make contact with overseas experts and gain greater insight into current developments in their intellectual field. The Fellows’ programs are expected to provide opportunities for them to make an impact on the wider Australian community and are therefore designed to be stimulating in a broad cultural sense as well. It is also expected that the Fellows will familiarise themselves with Australian developments and share the Australian experience on their return home. The duration of the visits is usually from one to three months, and awards will be tenable during the period 1 July 1984 to 30 June 1985 (inclusive).

Further information, including suggested guidelines for submissions, is available from the Secretary (Visiting Fellowships), Department of Education and Youth Affairs, PO Box 826, Woden, ACT 2606.
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