CONTENTS
President's Column .............................................. 81
Editorial .......................................................... 81
Nuclear Power and the Proliferation of Nuclear Weapons ... 82
Energy Research in S.A ......................................... 86
Two Professions: Physics and Engineering .................... 87
Comment: AIP's Submission to the National Technology Conference ......................... 88
Millimetre and Submillimetre Wave Research in Australia ........................................ 90
Letters .................................................................. 93
People ................................................................... 94
Book Reviews ....................................................... 96
Looking at the edge of the Universe ......................... 99
Physics Roundabout .............................................. 101

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EXECUTIVE
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Dr. J.G. COLLINS, Hon. Registrar (02 467 6134).

ADDRESS:
Science Centre,
35-43 Clarence St.,
Sydney, NSW 2000.
Telephone 29 7747. Telex 25578.

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All enquiries and correspondence concerning subscriptions to:
Australian Institute of Physics, Science Centre, 35-43 Clarence St.,
Sydney, NSW 2000. Telephone (02) 29 7747.

BRANCH SECRETARIES — ADDRESSES:
NSW  Mrs M. Welch
      Loreto College,
      Pennant Hills Road,
      NORMANHURST, NSW, 2076.
ACT  Dr G.A. Stewart
      Department of Physics,
      Royal Military College,
      DUNTRNOO, ACT, 2600.
SA  Dr K.J.W. Lynn
      Ionospheric Studies Group,
      Defence Research Centre, Salisbury,
      G.P.O. Box 2151,
      ADELAIDE, SA, 5001.
VIC  Dr J.D. Riley
      La Trobe University,
      BUNDOORA, VIC, 3083.
QLD  Dr P.E. Monro
      Department of Physics,
      University of Queensland,
      ST LUCIA, QLD, 4067.
WA  Dr C.E. Edwards
      Physics Department
      University of W.A.,
      NEDLANDS, WA, 6009.
TAS  Mr J. Boersma
      Tasmanian CAE,
      LAUNCESTON, TAS, 7250.

Assistant Secretary — Melbourne:
Miss Rosemary Daunt,
National Science Centre,
Chuillee Ross House,
191 Royal Parade,
PARKVILLE, VIC, 3052.

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Committee.
President's Column

I was interested to read the First Report of the Australian Optical Society (AOS) which was published in the March issue of the AP. This new, and obviously very active society, has not been formed as a formal professional society nor as a Group of the AIP. Nevertheless, I believe that the main impetus for the establishment of the Australian Optical Society came from members of the AIP and it is important for the AIP and the new society to continue their collaboration. Certainly at its 1983 meeting the Council of the AIP welcomed the formation of this new society and hopes that it will remain closely involved with the AIP.

As was also reported in the March issue, the American Institute of Physics has nine member societies with a combined membership of 75,000. The breakdown of members is particularly interesting with physicists accounting for only 55% and engineers and chemists accounting for a significant fraction of membership of the member societies. While there is no need for us in Australia to follow all that is American, it is obvious that we do so — either by choice or unwittingly — in many areas of social and professional structure. The formation of the AOS is probably an appropriate event to encourage the AIP to again look at its structure, its use of groups or member societies and, for example is it doing all that it should to look after the interests of physics teachers? I will encourage consideration of such matters at the 1984 meeting of Council. Another interesting feature of the American Institute of Physics is that only 44% of its members are employed in academic organisations and that the industrial employment of its members is growing. Still fresh (?) from my participation in the National Technology Conference, I would expect and hope that we will be following a similar trend.

The AIP has recently been approached by Cambridge University Press with a suggestion that we enter into an agreement for a joint AIP/CUP publishing programme. This would involve us setting up a small local board of editors who would suggest projects for publication and would consider proposals from authors for publication of text books or monographs under the scheme. I should be most grateful if members would let me know of their views on this and whether they would be interested in contributing to such a scheme as authors.

[Signature]

E.J. Wilson

Editorial

In Britain, the engineering profession is rapidly changing its organization and its status. An article from Physics Bulletin by Prof J. Finkelstein is reprinted in this issue of Aust. Phys to indicate some of the implications for physicists. In Australia, engineers have not yet proceeded along the path to chartered status, but their awards dominate the scientific industrial scene, probably by sheer weight of members.

Many employers, probably for the same reason, couch advertisements for technological jobs in engineering terms, and expect engineers as applicants. The suggestion that physicists could become "chartered engineers in applied physics" could perhaps solve this problem, and would certainly emphasise the continuity of the range from fundamental physics to the various branches of engineering. But care is required that physics does not become just another branch of engineering, because both fundamental and applied physicists derive strength from each other in a manner similar to the interaction between theoretical and experimental physics. Just think how insufferable the boffins would be if all applied physicists became engineers!

Considerable thought is required if engineers are to be attracted to AIP membership as well as vice versa. Such moves might in fact produce the sunrise that Barry Jones is looking for.

Jim Graham

The Australian Physicist, Vol. 21, May 1984 — Page 81
Nuclear Power and the Proliferation of Nuclear Weapons

R.A. Joseph, Department of History and Philosophy of Science, University of Wollongong, March 1984

Introduction
This paper is concerned with the links between nuclear power and the proliferation of nuclear weapons. There are two reasons why a study of the links between nuclear power and weapons is important. First, nuclear power is still a major force in the world energy. For instance, The French Government hopes that by 1990, 70 per cent of electric power will come from reactors. In Japan, where nuclear reactors generate 19 per cent of the electricity, the target for 1990 is 27 per cent (Time, February 13, pp 20-21). The diffusion of nuclear power technology could enable many semi-industrial or non-industrial countries to obtain the necessary skills, technologies and materials to build nuclear weapons. The spread of nuclear weapons, in turn increases the risk of nuclear war.

Second, the present lull in the debate over the links between nuclear power and weapons, is unlikely to last forever. Countries such as South Africa and Israel have been discreet in recent years over their nuclear weapons capability. It would, of course, only take a threat from a 'new' nuclear nation against one of these countries for it to become a live issue once again. The same is true of Argentina and Brazil, both of which are developing reactor programs. Argentina has recently reverted to civilian rule and Brazil has economic problems and this tends to make people less concerned about their nuclear programs. International complicity over the use of chemical weapons in recent years and the current accusations that Iraq is using such weapons in its war against Iran is a salutary example of how quickly international perceptions can change.

The present lull is also of little consolation to Australia. In the Pacific rim, South Korea and Taiwan still maintain substantial nuclear programs with targets of as many as 44 and 24 nuclear reactors respectively operating by the end of the century (Falk 1983). The proliferation of nuclear weapons to countries in the Pacific rim (especially Indonesia) would be of major strategic importance to Australia and could even force Australia into acquiring nuclear weapons.

Notwithstanding the current international preoccupation with strategic nuclear balance and arms negotiations between the super-powers, there has already been considerable debate and controversy over the links between and nuclear weapons. Much of this controversy has arisen out of differing perceptions over the extent to which nuclear power provides an attractive route to the production of nuclear weapons. There is growing evidence to suggest that knowledge about these links has been systematically and intentionally concealed (Falk, 1982, Jungk, 1978 and Patterson, 1976). However, a study of how technical arguments have been manipulated to achieve political and business interests would be the subject of another paper. The emphasis in this paper is on the technical aspects of the links between nuclear power and the proliferation of nuclear weapons.

This paper begins by outlining various opposing arguments: those which promote the view that nuclear power is an unlikely route to the proliferation of nuclear weapons; and, those which promote the view that it is an attractive route to weapons proliferation.

Having canvassed these arguments, the paper then proceeds to seek answers to four important questions. The answers show that there are strong links between nuclear power and the proliferation of nuclear weapons.

Opposing Arguments in the Debate.

For practical purposes, there are at present two nuclear explosives — plutonium-239 and uranium-235 (Maddox, 1975). The first must be made in nuclear reactors — for the time being, reactors using natural or slightly enriched uranium as fuel — the second must be made by means of some physical device for separating the isotopes from each other (ie uranium enrichment technology).

Given the current state of uranium enrichment technology, technical and economic barriers can prevent many countries from trying to enrich natural uranium to obtain -235 for weapons use (Maddox, 1975). Only the most technologically sophisticated countries can obtain fissile material by this route. For example, a new laser separation process (ALVILS — Atomic Vapor Laser Isotope Separation) under development at the Lawrence Livermore Laboratory is expected to be fully operational by 1989 (Falk, 1983). The Stockholm International Peace Research Institute notes that it is quite improbable that the process will be available to less technologically advanced countries, at least in the medium-term future (SIPRI, 1982). The more widely known centrifuge process of enriching uranium would require a considerable drain on a non-nuclear country's resources if it attempted to develop this technology without outside assistance (Maddox, 1975). However it would be wrong to believe that uranium enrichment technology cannot contribute to the proliferation of nuclear weapons. Its role in proliferation in the future will depend crucially on the further diffusion of existing enrichment technologies and the development of new technology (eg ALVILS). With this in mind, the present paper will concentrate on the route of most immediate concern-nuclear proliferation through plutonium-239.

Any nuclear reactor using uranium fuel will produce plutonium as a by-product, but the quantity obtained will depend on the design of the reactor, its power output, and the way in which it is operated.

There are various arguments which have been used to promote the view that commercial nuclear power reactors do not provide an attractive route to the production and therefore proliferation of nuclear weapons (Greenwood et al 1976 and Greenwood, 1977). These include:

- A small, simple reactor fuelled by natural uranium, together with a small reprocessing plant to extract plutonium from spent fuel would be less difficult to construct and less costly (by at least a factor of 10) than a commercial power reactor together with even a small commercial type of reprocessing plant. A non-nuclear country would therefore prefer this type of facility to the commercial reactor if it wanted to obtain plutonium for military purposes.

- A country could conceal its intentions to obtain weapons by obtaining a commercial reactor but even
then, a country may still be better off to construct special facilities clandestinely, or to use an existing research facility.

- Materials diverted from commercial reactors would not normally be well suited for weapons. This would add to the complexity of bomb design and increase the risk of failure.
- Production of high quality weapons material would require operating facilities in costly, non-optimum ways.
- International safeguard arrangements and political commitments would inhibit most countries from diverting fissile material from commercial reactors.
- The designing and building of an efficient and defensible nuclear weapon is considerably more difficult than creating a nuclear explosion. The military value of a nuclear weapon could be severely reduced without this additional technology.

On the other hand, arguments have been used to suggest that commercial nuclear power reactors could be helpful to a weapons program (Greenwood et al 1976 and Greenwood 1977). These arguments include the following:

- A civilian nuclear industry would provide a base of relevant technology and trained manpower which could be utilized for weapons purposes.
- If a country's nuclear industry included facilities for reprocessing spent fuel and/or facilities for enriching uranium, these could be used for weapons purpose. (There would be greater technical difficulty in using enrichment facilities for this purpose however).
- New reactor types that use weapons-grade material as fuel might be introduced commercially.
- Countries with a growing nuclear industry can hint subtly or openly that they have nuclear weapons to achieve political objectives.

The Ranger Uranium Environmental Inquiry concluded, 'The nuclear power industry is unintentionally contributing to an increased risk of nuclear war. This is the most serious hazard associated with the industry' (Ranger Uranium Environmental Inquiry, 1976).

However, summarising the debate as a catalogue of arguments for and against is not altogether that helpful. A better understanding of the links between nuclear power and the proliferation of nuclear weapons can be obtained by asking for pertinent questions:

- can plutonium diverted from commercial reactors be readily used to make nuclear bombs?
- is it becoming easier to obtain nuclear technology and fissile materials to construct bombs?
- how effective are international safeguards?
- do recent developments on the international scene provide any evidence of strong links between nuclear power and nuclear weapons?

**Plutonium and Nuclear Bombs**

Nuclear policy has often been justified by the belief that for making nuclear bombs, reactor-grade plutonium produced by the normal operation of uranium fuelled power reactors is necessarily much inferior to specially made weapons-grade plutonium (Lovins, 1980). Reactor grade plutonium contains plutonium-239 and plutonium-240. Plutonium-239 is easily fissioned and ideal for making bombs. Plutonium-240 spontaneously emits neutrons and its presence can cause a nuclear reaction to begin before a bomb is fully assembled. Therefore, reactor-grade plutonium is far more likely to cause unintentional explosions and its potential use by amateurs is generally not considered to be serious problem. Moreover, it would be very difficult for non-governmental groups to remove the plutonium from highly radioactive fuel rods.

However, while the above arguments contain, in certain circumstances some validity, plausible counter measures can be taken to render them false. First, as Lovins has argued, high levels of plutonium-239 may reduce the expected yield of a crudely made bombs, but these drawbacks can be easily overcome by more clever design without necessarily using high technology (Lovins, 1980). The design work could be carried out by a small group of people, none of whom has ever had access to the classified literature who could get by with modest machine shop facilities that could be contracted for without arousing suspicion (US Congress, 1977). Second, even if a bomb with some Pu-240 (and therefore with reduced yield and military usefulness) was constructed, such a bomb would still remain attractive to non-government or terrorist groups interested only in a single weapon. It is possible to design low-technology devices with weapons grade plutonium that would reliably produce explosive yields up to the equivalent of 10 or 20 kilotons of TNT. With reactor-grade plutonium it is possible to design low-technology devices with probable yields 10 times lower than those mentioned above, but yields in the kiloton range could still be accomplished (Lovins, 1980). Third, for a government of even a country with a low level of technological development, there is no reason to believe that reprocessing is too difficult. Falk argues that detailed plans (costing as little as US $5 million) for simple reprocessing plants are readily available (Falk, 1983). The US Office of Technology Assessment has concluded that 'it is well within the capability of many developing countries to construct their own reprocessing plants to extract plutonium from spent fuel for use in weapons' (Falk, 1983).

In short, their implication that reactor grade plutonium is not very dangerous, or unlikely to be attractive to governments is wishful thinking, and causes the proliferation risks of civil nuclear activities to be gravely underestimated. The somewhat greater technical difficulty of using power reactor Pu for effective military bombs may be more than compensated by the greater political and economic ease of obtaining that Pu' (Lovins, 1980).

**The Spread of Nuclear Technology and Fissile Material**

The principles on which nuclear explosions are based have been public knowledge since 1946. Numerical data on the nuclear properties of uranium and plutonium isotopes are available in the open literature. A small group of competent physicists could devise the principles on which nuclear weapons might be constructed in a matter of weeks (Maddox, 1976). Solutions to the many practical problems in bomb construction, traditionally thought of as being a major obstacle, are now available in the open literature (Maddox, 1976). The barrier to building a nuclear weapon does not appear to be the technology, but rather access to a supply of fissile material.

The proliferation of fissile materials is also greatly enhanced by the spread of the nuclear industry around the globe. The plutonium discharged from a single large power reactor suffices for about 100 bombs per year (Lovins, 1980). In 1981, the amount of plutonium being produced by the world's commercial nuclear reactors amounted to some 30 tonnes per year — enough to make 5000 bombs annually. In addition, more than 200 tonnes had already been accumulated in spent reactor fuel rods — enough for 360000 nuclear weapons (Falk, 1983).

Developed countries have been in very keen competition to sell nuclear reactors and related facilities to developing countries. This also tends to speed-up the
diffusion of nuclear technology (SANA, 1983). For instance, India was the first developing country to operate a power reactor (in 1969) and by late 1981, Pakistan, Taiwan, Argentina, South Korea and Brazil had operational power reactors. Other developing countries that were either constructing power reactors or had firm plans to do so included China (with Hong Kong), Cuba, Egypt, Mexico, Philippines, South Africa and Turkey. Further third world countries have expressed strong interest in nuclear power. Over the last 10-15 years, the spread of nuclear technology to developing countries has greatly increased. As a consequence, the availability of fissile material has also increased.

Nuclear Safeguards

International attempts to regulate the diffusion of nuclear technology are based on the Nuclear Non-Proliferation Treaty (NPT), supplemented by the Euratom Treaty and various bilateral agreements including those of the so-called London Suppliers Group. The most important of these, the NPT, which came into force in 1970 is considered here. This treaty is essentially an agreement between various countries already possessing nuclear weapons (UK, USA, and the USSR) and countries which do not possess such weapons. The nuclear weapons states agree not to transfer nuclear explosives, or means for their construction, to any state, whether or not a party to the treaty, and also to cooperate with other countries in developing peaceful nuclear technology. In return the non-weapons states agree not to manufacture nuclear explosives and accept international safeguards specified by the International Atomic Energy Agency (IAEA) on all their peaceful uses of nuclear technology. These safeguards are to ensure that no material is diverted for the manufacture of weapons (Braun, et al 1983).

However the Nuclear Non-Proliferation Treaty has not been signed by some 50 countries. This includes two acknowledged nuclear weapons states (France and China), three suspected ones (India, Israel and South Africa), several others which are considered to be rapidly moving towards a nuclear weapons capability (Pakistan, Brazil and Argentina) and all major developing countries except Iran and Mexico (Gummett, 1981). The use of plutonium from commercial nuclear reactors is therefore particularly relevant in situations in which governments seek to avoid the full rigor of the safeguards system (Maddox, 1976). The spread of nuclear technology and fissile material, largely without reference to safeguards, cannot therefore be ignored as a source of proliferation.

However, a number of major problems with the NPT have been identified. These include the following:
- No sanctions exist for countries which break the safeguards they have agreed upon. The sole deterrent to the misuse of nuclear material is the threat of discovery and possible withdrawal of cooperation by other States.
- The sheer quantity of material which must be accounted for causes problems. It has been calculated, for example, that with safeguards which are 99.9% effective, enough plutonium would still be ‘lost’ to produce one nuclear weapon per week (1980 figures) (Braun et al, 1983).
- Article VI of the NPT obliges all states that already have nuclear weapons to pursue the cessation of the nuclear arms race. This most definitely has not happened.

The IAEA states its objectives as: ‘the timely detection of the diversion of significant quantities of nuclear materials to nuclear weapons or other nuclear explosive devices or for purposes unknown’ (SANA, 1984). A significant quantity is approximately the quantity of nuclear materials required for a bomb (8kg plutonium 239, 25kg uranium 235). A timely detection is defined as detection of the diversion within the time estimated for the fabrication of the nuclear material into metallic components of a bomb. For plutonium 239 this is 7-10 days. The IAEA had 138 inspectors in 1980 to cover 744 nuclear facilities. Plants are therefore inspected only once or twice a year (Falk, 1983). The limited frequency of inspectors makes it difficult to be sure that no diversion of nuclear materials has taken place.

Part of the IAEA’s charter is to promote the use of nuclear power. However, in the past the IAEA has spent considerably less than 20 per cent of its budget on implementing safeguards. The IAEA therefore finds itself in an ambiguous position (SANA, 1983).

Safeguards as presently constituted are not an effective way of preventing the proliferation of nuclear weapons. If fast breeder reactors, which use weapons-grade plutonium as a fuel become common, the risk of proliferation may increase. Commercial pressures also increase the risk of proliferation; it is in the commercial interests of some non-signatories to the NPT, France and South Africa, which are major suppliers to sell as much nuclear technology and uranium as they can.

Recent Developments

When India exploded a nuclear device in the Rajasthan desert in 1974, the gap between the civilian and military uses of the atom effectively disappeared. That device was constructed using plutonium extracted from a nuclear reactor provided for research purposes by the Canadians (Maddox 1976). More recent developments have reinforced the link between nuclear power and nuclear weapons.

For example, the Israeli attack on Iraq’s ‘Osirak’ and ‘Izis’ reactors situated near Baghdad in June was described by the Israeli government as a defensive step to prevent the development by Iraq of atomic bombs. This attack was made by a non-signatory state upon a signatory state of the NPT. The impotence of other signatory states following the attacks highlights the weaknesses of international treaties and safeguards.

Perhaps more important than bringing the value of safeguards into question, the Israeli attack restored public appreciation of the technical impossibility of separating clearly the peaceful from the military use of nuclear energy. The attack established the precedent of a deliberate pre-emptive strike by one nation against the nuclear capacity of another nation and this highlights the importance of non-proliferation to nuclear proliferation (Gummett, 1981). Recent accusations that Iraq has used chemical weapons in its war against Iran

The Australian Physicist, Vol. 21, May 1984 — Page 84
(The Guardian Weekly 18 March 1984), raises the question of what Iraq might have done if it had access to a small nuclear weapon.

Finally, the need to protect the growing fissionable material from diversion has led to concern over the severe measures of social control which may be necessary to run a nuclear state. The prospect of severe social controls to prevent the construction of nuclear weapons by small groups or individuals cannot be denied (Jungk, 1978).

The issue of social control raises the question of fast-breeder reactors and the plutonium economy. Fast-breeder reactors can convert uranium-238 into plutonium for use as fuel in commercial nuclear reactors. From fast-breeder reactors plutonium will be mass-produced, transported to fuel fabrication plants and loaded back into commercial power reactors. In reprocessing plants, the spent fuel would be treated to extract plutonium and uranium, also for transport to plants to be made into fuel. Over time, the prospect is for electricity production in industrialised countries to be built around flows of plutonium.

The present problems of accounting for tiny flows of plutonium within the conventional nuclear fuel cycle would be greatly exacerbated with the advent of fast-breeder reactors. The impact of this on national security and social controls has already been well documented (Jungk, 1978, and Falk, 1983).

Some time this year France will start-up Super-Pheenix, the world's first commercial breeder reactor. This represents the first step of the next major escalation of nuclear technology. A number of French officials have implied the use of French fast-breeder reactors as a source of plutonium for bombs. For instance, General Thiry in 1978 stated:

France knows how to make nuclear weapons of all patterns and all powers. She will be able, rather cheaply, to make great quantities of them as soon as the fast breeder reactors furnish her with plenty of the plutonium needed (J. Gallacher, The Guardian Weekly, 26 February, 1984, p.2).

Electricité de France, has stated in its house journal that current sources of plutonium are inadequate for the expansion in French nuclear arms:

A reinforcement is needed, and it ensured (after Pheenix) by Super-Pheenix, which will produce enough plutonium to make about 60 bombs each year. Under these conditions, Super-Pheenix would cover 80% of the tactical needs of the French nuclear military force (J. Gallacher, The Guardian Weekly, 26 February, 1984, p.2).

It is perhaps sobering to recall that France has not signed the NPT and has already provided sensitive nuclear facilities to Brazil and South Africa.

Conclusion

The link between nuclear power and nuclear weapons is complex involving many technical, economic and social factors. Much of the traditional wisdom concerning the existence of adequate technical barriers which prevent the use of nuclear reactor waste as a source of fissile material for weapons and the effectiveness of safeguards needs to be brought into question. Changing technology and rapidly changing international situations demand a major re-think of this traditional wisdom. The link between nuclear weapons and nuclear power cannot be ignored by any responsible or concerned group within the community, including physicists.

As a recent Scientists Against Nuclear Arms (SANA) editorial (SANA Update, Jan/Feb 1984) has concluded: .... the onus is on scientists, who, as a group, provided this knowledge, to pinpoint the problems associated with it (nuclear technology) as honestly and completely as possible, and then to seek the most viable solutions and alternatives.

In the rapidly changing world political situation the Australian physics community has an obligation to the community at large to ensure that all aspects of the debate concerning nuclear weapons and nuclear power are given adequate public attention.

Indeed a recent report from SANA (UK) has put forward some concrete suggestions which could help to avoid the proliferation of nuclear weapons in developing countries. They are listed below:

1. There should be separation of the safeguards and promotional aspects of the IAEA’s work into two independent organisations.
2. The promotional aspects of the IAEA’s work, possibly reduced in scope, could be incorporated into an International Energy Agency. The new organisation would be chargéd with promoting all types of energy development in the Third World and in particular aim to assess the most appropriate energy technologies for each developing country.
3. The nuclear supplier states must agree that they will only supply nuclear equipment to countries which sign the NPT and agree to “full-scope” safeguards at all their facilities.
4. The nuclear states, in particular the US, USA and USSR that have signed the NPT, must fulfil the obligations under Article VI to proceed immediately with significant moves towards reducing their nuclear arsenals.
5. The nuclear weapon states must participate in the treaty more attractive by providing internationally agreed, legally binding security assurances not to use nuclear weapons against the non-nuclear weapon states that sign, the NPT (SANA, 1984).

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References


**Energy Research in S.A.**

Grants totalling $311,631 for 14 South Australian energy research projects were announced last November. The successful projects were selected from 35 grant applications received by the State Energy Research Advisory Committee.

Many of the projects given support addressed the important challenge of keeping energy costs to a minimum.

**SUMMARY OF GRANTS**

1. **$50,000 — Shedden Pacific Pty. Ltd.**
   A new project which will take to a further stage a feasibility study on the generation of electricity from gas produced by the underground gasification of Leigh Creek coal. This stage of the project will enable one hole to be drilled to improve the reliability of data, provide information on coal porosity and allow a test ignition to be performed. ETSA is actively involved in the project and interest has been expressed by the U.S. Department of Energy and the American companies, Gulf Oil and Arco.

2. **$70,000 — ENRECO Pty. Ltd.**
   A new project to design and build a 20 kilowatt Organic Rankine Cycle engine and operate it using hot bore water as the heat source. The eventual trial and evaluation of the system using hot bore water will have an impact on remote area power supply alternatives. The project is expected to generate local manufacturing opportunities.

3. **$28,500 — Department of Architecture, University of Adelaide**
   A new project to quantify the relative merits and costs of refrigerative and evaporative cooling systems in South Australian dwellings, taking account of thermal comfort, energy consumption and operating costs, capital cost and water consumption. There is a serious lack of data in this area in Australia and information is urgently required in South Australia because of the increasing trend towards the refrigerative units which use more electricity.

4. **$23,850 — Australian Mineral Development Laboratories**
   The second year of a two year project to research low level concentration of photovoltaic cells used in flat plate applications. Low level cells are substantially cheaper than the high level cells currently in use. Phillips of Haddon are working with AMDEL on testing the cells and on completion of the trials, it should be possible to move into a commercial phase with a good market potential in Australia and overseas.

5. **$12,000 — EUWA (Australia) Pty. Ltd.**
   A new project to assemble a small plant capable of producing good drinking water from bore water using a solar cell/demineraliser system. This project has great potential for remote area locations.

6. **$8,750 — Australian Mineral Development Laboratories**
   Second year of a two year project to assess the performance characteristics of a range of domestic solid fuel heating appliance and fuel types. Solid fuel appliances are becoming popular for space heating and the results of testing will assist industry in the design and development of their product.

7. **$30,000 —**
   Tenders will be called for a proposed systematic monitoring of wind data in South Australia. This will produce essential baseline data for future wind energy applications.

8. **$18,360 — G.M.I. Building Education Programme**
   Second year of a three year national programme to develop energy efficient dwelling designs for a range of Australian climates, develop effective insulation methods for solid masonry walls and to disseminate this information to the building industry in the southern States. This project is also receiving support from the Commonwealth, the C.S.I.R.O., and various State bodies.

9. **$6,421 — Mr. A.J. Mortimer of Evanston Nursery**
   Second year of a two year project to demonstrate self-sufficient heat storage capacity in a solar greenhouse. The project uses a heat bank to eliminate the need for supplementary heating overnight.

10. **$5,000 — South Australian Energy Council**
    A new project to collate, edit and analyse solar data currently being collected from a number of locations around the State to help determine the most appropriate type of solar collector for various locations.

11. **$25,000 — School of Metallurgy, S.A. Institute of Technology**
    Continuing project aimed at processing coal from the Wakefield deposit to produce a fuel which is combustible in conventional boilers following a reduction in the sodium content. This stage will complete the pilot scale work and test the various options available.

12. **$2,000 — School of Mechanical Engineering, S.A. Institute of Technology**
    Final year of a project to improve the energy efficiency of tillage tools. The data collected will now be widely distributed.

13. **$2,000 — School of Mechanical Engineering, S.A.I.T.**
    Upgrading of a solar radiation measuring station capable of continuous recording of all parameters pertinent to the design of solar energy installations.

14. **$30,000 — Department of Mines and Energy**
    For maintenance and upgrading of the Energy Library within the Department. The library was established by SENRAC funding and its upkeep is accepted as a responsibility of the Committee.
Two professions: physics and engineering

by Professor L. Finkelstein, F Inst P


The profession of physics and the profession of engineering are overlapping and complementary, as well as being highly interdependent. It is therefore a matter of regret that the recent major developments relating to the engineering profession in Great Britain, regarding its organisation and system of education and training, have not provoked a wider and deeper debate among physicists about their own profession.

Physics is of course distinct from engineering in both nature and scope. Many of the tasks of the physicist are special to the profession and different from the tasks of engineers. There is the advancement, organisation and preservation of fundamental physical knowledge, and also the role of physics in general culture. These aspects, and others, give physicists distinct tasks in research, scholarship and teaching.

In the application of physics, however, the nature and role of the physics and engineering professional are scarcely distinguishable. Many of those educated as physicists enter, through training and experience, one of the branches of the engineering profession, and these physicists will be profoundly affected by the changes mentioned earlier.

The Engineering Council, formed as a result of the Finniston enquiry into the engineering profession and the national debate that followed, has now taken over responsibility for the qualification of engineers. It will act through nominated professional engineering institutions, and set standards for the recognition of the education, training and experience required for the attainment of the title ‘Chartered Engineer’. There is every prospect that the Engineering Council, building on the foundations laid by the professional engineering institutions and in cooperation with them, will achieve an enhancement of the quality and status of engineers.

The physics profession must examine itself in the light of these developments. We may decide to remain broadly as we are. We may organise the education and training of physicists so as to facilitate their entry into appropriate branches of the engineering profession. We may develop our profession so as to establish for ourselves an organisation and a system of education and training comparable with those of the engineering profession and leading to the establishment and general recognition of the title and status of ‘Chartered physicist’. Finally we may organise ourselves in such a way as to achieve for applied physicists, who are those most affected, recognition as chartered engineers in their capacity as applied physicists. These options really must be discussed urgently and thoroughly by the whole of the physics profession.

While I personally would advocate progress and change, and in particular the establishment and promotion of either the status of chartered physicist or preferably that of chartered engineer in applied physics, I would rather discuss developments in engineering education and training, and the impact they must have on the formation of physicists.

A consultative document published by the Professional Institutions Directorate of the Engineering Council in the autumn of 1983 on standards and routes to engineering professional registration sets out the background to present developments in the formation of engineers and outlines future trends. I shall not discuss this document in detail but rather identify some key concepts and elements of the present and proposed schemes which are fundamental and will have a major impact on the education of physicists, no matter what the fate of the detailed Engineering Council proposals.

Developments in the area of education, training and experience must be considered. The first important development is the significant and increasing importance given by the engineering profession to professional accreditation of educational courses. This is based on fairly specific recommendations on content, teaching methods and standards, and very detailed examinations of the courses to be accredited. Careful thought must be given to whether and how the physics profession should follow the engineers in this matter. On the one hand there is immense value in the academic independence of institutions of higher education; on the other, the education of the profession cannot be left entirely to teachers. It should be a matter for the profession as a whole.

The second development in engineering courses is the increasing emphasis being given to design, application and management. The value of an education in physics is its fundamental nature, generality and breadth. It is often argued that application, design and management are best learned by experience, but the engineering profession increasingly recognises that preparation for work in these areas must form part of normal education and training. This is equally important for all those who will work as applied physicists.

The engineering profession is developing educational courses with additional content and also courses of four years' duration. It has always been recognised that physicists entering research require an education beyond the compass of a three-year degree; physicists entering teaching receive a similarly extended education. There is a good case for extended courses for physicists who will work as applied physicists or engineers, and this should be examined and debated urgently.

In addition, the engineering profession is working towards a system of practical training which is well structured, improved in content and standard, more widely implemented and better controlled. This again offers models for the physics profession to examine. Finally, the matter of experience. It is, of course, an essential element of professional formation, but no substitute for what should be provided in formal education and training.

Physicists have made, and are making, great contributions to society at large, both in their own sphere of fundamental physical science and in the broader area of technology. The significance of their contributions and the effectiveness of the physics profession are widely recognised. However, for any profession the price of importance and status is vigilance over its own activities. We must not neglect the developments in the engineering profession.

The Australian Physicist, Vol. 21, May 1984 — Page 87
A Comment on AIP's Submission to the National Technology Conference, September 1983

Jean Moran, School of Science, Griffith University.

The AIP's submission to the National Technology Conference (Australian Physicist, November 1983) is commendable for its attempt to locate the role and contribution of physicists within the broader context of industrial-technology policy. Noteworthy also are its specific recommendations on forging closer links between science and industry, mechanisms to improve industrial research and development performance in technology-intensive industries and ways to offset the "modest contribution" technology has customarily made to Australia's industrial base. However the very scope of its recommendations is occasionally uncritical in ways which tend to blur the focus of its policy implications.

This is perhaps most evident in its discussion of education, community attitudes, employment and social implications.

Noting that physicists have a strong contribution to make to at least 12 of the nominated 16 'sunrise' industries, the Submission lists several hurdles to the realisation of more practically-oriented physics education and the consequently restricted input of physicists to the high-technology process. Inter alia, the Institute recommends a stronger loading of 'industrial segments' in existing science courses at tertiary institutions, both to foster 'hands-on' experience and to facilitate the more pointed interaction between researchers and industry.

What tends to be glossed over here is:
(a) the historical influences on the development of Australian physics; and
(b) how realistically the recommended changes can be accomodated at the speed-of-lighting pace that the Minister for Science and Technology presently prescribes.

Historically, physics in Australia has developed within the mould of big science objectives in a country with little science resources. As Sir Frederick White commented at the Bicentennial History of Science Conference in 1982, CSIRO's radiophysicists recruited in the immediate post-World War 2 period were virtually given carte blanche in setting research programs in order to retain and attract personnel of the highest calibre. Physicists, in short, formed a privileged enclave within the research community, and arguably set the pace for determining research directions which would not only put Australia 'on the map' but also define Australian scientific research as a conspicuous resource of excellence.

The AIP submission keenly recognises the weight of changed political priorities, where intellectual capital rather than basic research per se is heralded as a critical factor in founding skills-based industries and generating the high value-added products necessary for the nation's future economic growth. Or, as Barron Jones more bluntly puts it:

Australia needs to produce its Einsteins and Westinghouses as well as its Rutherfords. However the submission tends to underestimate: how easily existing tertiary institutions can practically accommodate the sorts of changes recommended; and how the two disparate reward systems (academic vs industry) within tertiary institutions may be integrated.

There is also a strong case for broadening the base of physics training to include fields such as communications and studies of science and technology in society. Industrial experience for physicists and scientists may overcome deficiencies in adapting innovative ideas to the needs of the market place. But without the ability to translate these ideas into propositions likely to appeal to financial backers, the innovative process is still impeded.

Less self-evident perhaps is the need to promote increased awareness of the social implications of technological change as a matter of priority rather than (as at present) a soft option. As Barry Jones noted in a recent address to graduating science students, scientists have not generally been very helpful in raising social or community consciousness on scientific matters. 'Scientists', he observed, 'are analysts not synthesisers... (they) like to avoid political involvement.' So much so that 'the scientific community has taken a profile so low as to be indistinguishable from the horizon'.

While the AIP submission is to be commended for its attempt to redress this syndrome, its stated preference for emphasizing policy issues related to 'economic outlook' implicitly relieves questions of social impact and responsibility outside the realm of scientific concern. This demarcation of policy concerns leads the institution to make recommendations to remedy both the projected shortfall of physicists and negative community attitudes to science — without making any connection between the two. Questacon centres and popular science museums may well have the effect of promoting positive attitudes to science. But will this be sufficient to overturn anti-technology responses if the perception of society at large is that the manufacture of technology is conducted without social conscience. Put differently, without critical appreciation by professionals of the social ramifications of rapid technological change, it may prove increasingly difficult to persuade the 55 year old migrant worker at Wollongong that technology policy has any relevance to groups other than its entrepreneurial and professional beneficiaries — let alone any contribution it may make to 'preserve his personal dignity'.

A related consideration is that the needs and demands of the market place are not defined in a social vacuum. Neither is the technological infrastructure it spawns. If, as some commentators suggest, the success of Australia's hi-technology strategy hinges on filling existing gaps in market niches, then neglect of the social dimension could well deny important cues for identifying appropriate technology development.

What tends to be overlooked in the present articulation of hi-technology strategy (and eliminated in the nomenclature of "sunrise industry policy") is that...
wealth-generation minus social cost may not result in net national gain in the long term. Despite forceful arguments for promoting sunrise industries as a mechanism for wealth-generation, the connection between wealth generation and job creation in a dual labour economy is assumed rather than demonstrated.

The catch all for wrapping up what could well turn out to be disparate policy wedges is the political voluntarism of 'where there's a will, there's a way' and appeals to 'bold and imaginative thinking'. The question remains, 'whose will and which way?'

The objections raised here are by no means unique to the AIP's submission to the National Technology Conference. Nor are they intended to mitigate the contribution of its specific recommendations to the ongoing debate about industrial-technology policy. We sleepers may indeed be waking too slowly, but without hard-nosed critical analysis, policy directions could well degenerate into a case of more haste and less speed — with 'progress' in the twilight zone of neither.

Australasian Remote Sensing Conference

INTRODUCTION

The First Australasian Conference on the Physics of Remote Sensing of Atmosphere and Ocean was held at Ormond College, Melbourne University, from 13 to 16 February 1984. The conference was co-sponsored by CSIRO and the Australian Academy of Science, with the support of a number of other organizations including the Australian Institute of Physics.

Attending were approximately 130 delegates from 7 countries, representing various government and semi-government bodies, tertiary education centres, and private organizations involved in the collection and analysis of information about the sea and atmosphere.

FORM OF THE CONFERENCE

Several review papers of about 40 minutes duration were presented by distinguished scientific authorities. These reviews summed up the current state of research, development or operational methods in key areas of remote sensing. Speakers included in this group were:

- Dr. Ian Bourne of Melbourne University, describing acoustic sounding devices, their advantages and limitations.
- Dr. William L. Smith of the NOAA/NESS Development Laboratory, USA, on satellite passive remote sensing in meteorology.
- Dr. Ed. R. Westwater of NOAA, Boulder USA, on the innovative PROFILER system, which combines ground based and airborne radiometers with VHF and UHF radars to produce wind, temperature and humidity soundings of the atmosphere.
- Dr. Richard M. Schotland of the University of Arizona, on lidar soundings of the atmosphere by the differential absorption (DIAL) method. The latter is used to determine the concentrations of pollutants, or of naturally occurring suspended particles, in the atmosphere.
- Dr. Mal L. Heron of James Cook University in Townsville, on that institution's HF Ocean Surface Radar and its capability for the remote sensing of sea state (eg. wave height and period).

Approximately 50 other papers were presented. These were of 20 — 30 minutes duration and gave authors the opportunity to reveal the results of their latest research, or to describe the development of some new technique or equipment.

REMOTE SENSING IN AUSTRALIA

Because of the large volume of papers it is of course not possible to summarize their contents here. However some papers should be especially noted, because they demonstrate the breadth, and the success, of involvement by Australian scientists in the remote sensing field. Some developments in the area are unique to this country and have a high potential for commercial exploitation.

Some of the highlights of significant work of this type, detailed at the conference, include:

- Dr. Ian Bourne's pioneering work on acoustic sounders at Melbourne University.
- construction of the HF Ocean Surface radar at James Cook University, Townsville, by Dr. Mal Heron's team.
- work on wind and turbulence measurement undertaken at Adelaide University by Dr. R.A Vincent and others involved in the VHIF Radar project.
- development of the first airborne laser system capable of remotely sensing the absorbing and scattering characteristics of sea water. This system was described at the conference by Dr. David M. Phillips of the Electronics Research Laboratory, Department of Defence.
- the Jindalee over-the-horizon radar described by Dr. Stuart Anderson (Department of Defence Research Centre). Amongst other capabilities, this instrument can be used to sense ocean wave heights and surface wind velocities at great distances.
- investigations of the structure of cirrus cloud, using a pulsed ruby laser, by the team led by Dr. C.M.R. Platt at the CSIRO Division of Atmospheric Research, Aspendale. This work has special application to climatic modelling.

There are many other examples of first-class remote sensing research in Australia. Several tertiary institutions are devoting considerable effort to establish ambitious programmes: for instance the University of New South Wales has opened a Centre for Remote Sensing, and WAIT has set up a multi-disciplinary team with major projects in satellite soundings, lidar and acoustic radar.

MANUFACTURER'S DISPLAYS

An interesting feature of the conference was the display and demonstration of a range of modern remote sensing instruments by manufacturers and agents.

Instruments shown included high resolution acoustic sounders, lidar ceilometers and laser visibility meters.

Many of the devices represented considerable improvement in flexibility, as unlike many conventional systems, they can be operated continuously or at call.

CONCLUSION

The conference provided many opportunities for scientists interested in the field to discuss equipment, methods and results. Meetings such as this help determine the direction of future research projects.

Because of the undoubted success of the inaugural Conference, it is likely that further such events will occur on a semi-regular basis.

J. Kingwell
Bureau of Meteorology
Darwin N.T.

The Australian Physicist, Vol. 21, May 1984 — Page 89
The aim of this Symposium was to bring together the many small and isolated groups working or commencing to work on millimetre or sub-millimetre (MSM) wave research in Australia, in that part of the band from 100 to 10,000 GHz. It attracted about 50 participants from nine different research establishments in Australia plus three invited speakers from overseas. The host institution was the Plasma Research Laboratory within the Research School of Physical Sciences, Australian National University (ANU), with sponsorship from the Australian Radio Research Board and the AIP.

The MSM band of the electromagnetic spectrum is of growing importance in a number of branches of physics, having applications in plasma physics, radioastronomy, defence, molecular spectroscopy and possibly also in biology (non-thermal effects in cells). It is situated in what was once considered to be a gap in the spectrum between light and radio waves where there was a scarcity of sources, detectors and techniques for handling the radiation. Nowadays this region is becoming increasingly accessible with the development of molecular lasers operating at frequencies as low as 150 GHz and conventional microwave sources and gyrotrons operating at frequencies up to 300 GHz and beyond. In this region neither conventional optical techniques (i.e., geometrical optics) nor single-mode waveguides can be generally employed and various quasi-optical techniques to handle the radiation are still in evolution. With a number of new groups in Australia just beginning to work in the MSM region, and the total number of groups now reaching about 10, the need arose for this first Symposium on Millimetre and Submillimetre Wave Research in Australia. It followed naturally from an earlier series of Symposia on Millimetre-wave Techniques which was also sponsored by the Radio Research Board. The most recent of these was held at CSIRO Division of Radiophysics (Epping, NSW) in February 1980.

Much of the established MSM research in Australia has developed from the needs of plasma diagnostics and

<table>
<thead>
<tr>
<th>Institution</th>
<th>Group</th>
<th>Contacts</th>
<th>Interests</th>
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<tbody>
<tr>
<td>University of Sydney</td>
<td>Plasma Physics</td>
<td>G.F. Brand, L.S. Falconer, B.W. James, L.C. Robinson</td>
<td>Plasma diagnostics, Gyrotrons, Lasers, Scattering, Interferometry, Optical Components</td>
</tr>
<tr>
<td></td>
<td>Electrical Engineering, Air Navigation Group</td>
<td>J.G. Lucas</td>
<td>Solid state sources and mixers up to 100 GHz, Modelling for navigational aids up to ~ 100 GHz.</td>
</tr>
<tr>
<td>University of NSW</td>
<td>Physics Astrophysics Group</td>
<td>J.W.V. Storey</td>
<td>Observations from far-infrared to millimetre wavelengths, Instrumentation including Detector Arrays, Antennas and Lasers</td>
</tr>
<tr>
<td>CSIRO Division of Applied Physics, Lindfield</td>
<td>IR and Sub-MM Spectroscopy</td>
<td>C.H. Burton</td>
<td>Spectroscopy, Analytical and Industrial Measurements, Sources, Detectors, Polarising Michelson Spectrometers</td>
</tr>
<tr>
<td></td>
<td>MSM Technology</td>
<td>J.C. Macfarlane, L.B. Whitbourn</td>
<td>Lasers, SIS (Superconductor-Insulator-Superconductor) Mixers, Fourier Transform Spectroscopy, Optical Components (Grids, AR coatings etc.) Microbolometers and Antennas</td>
</tr>
<tr>
<td>CSIRO, Radiophysics, Epping</td>
<td>MM-Wave Astronomy</td>
<td>R.A. Batchelor, B.J. Robinson</td>
<td>MM-Wave Astronomy, Instrumentation including Masers, Schottky Mixers, SIS Mixers and Antennas</td>
</tr>
<tr>
<td>University of Queensland</td>
<td>Physics Microwave Group</td>
<td>N.R. Heckenberg</td>
<td>MSM Lasers and CO₂ pump lasers, pulsed and CW. Output couplers, pump beam distribution and fine tuning effects in optically pumped lasers</td>
</tr>
<tr>
<td>RMIT, Melbourne</td>
<td></td>
<td>A.Z. Tirkel</td>
<td>Integration of digital and MM-Wave devices up to ~ 100 GHz.</td>
</tr>
<tr>
<td>Electronics Research Laboratory, Defence Research Centre Salisbury, S.A.</td>
<td>Tropospheric Studies Group</td>
<td>K.B. Whiting</td>
<td>Work is commencing on MM-Wave propagation and scattering (theoretical and experimental) up to ~ 100 GHz.</td>
</tr>
</tbody>
</table>

The Australian Physicist, Vol. 21, May 1984 — Page 90
this was reflected in the papers presented at the Symposium. There were two sessions on plasma diagnostics, dealing principally with interferometric and scattering diagnostics using submillimetre waves, and a complementary session on MSM lasers. Some of the other topics treated, and currently under study in Australia, are Gyrotrons (1 session equivalent), Optical Components (1 session), Spectroscopy, Astronomy, Detectors and Waveguide Devices (1 session). In all there were 8 invited reviews, 25 contributed papers and 2 poster papers presented. There was also a permanent display of MSM devices and products from various laboratories and suppliers of MSM devices and products from various laboratories and suppliers which included a fully operational, portable Polarising Michelson Fourier Transform Spectrometer covering the band from 100 GHz to 3000 GHz. A little more of the flavour of the Symposium can be gleaned from Table 1, which lists the titles of the review papers and their authors. A useful by-product of the Symposium was that it allowed all Australian groups in the field to be identified. A list of the groups with a very brief indication of their interests is given in Table 2. In was generally agreed by participants that the Symposium was successful in promotion cooperation and communication among the Australian MSM groups and that a second Symposium should be held in Sydney in about two years time.

Further details of this past or the next Symposium may be obtained from the undersigned.

L.B. Whitbourn
CSIRO Division of Applied Physics
PO Box 218
Lindfield NSW 2070

TABLE 1
Review papers at the MSM Symposium

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
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<tbody>
<tr>
<td>Prof. H.R. Fetterman</td>
<td>New Developments and Applications of MSM Technology</td>
</tr>
<tr>
<td>Electrical Engineering, UCLA</td>
<td>Plasma Diagnostics in the Submillimetres Region</td>
</tr>
<tr>
<td>Prof. N.C. Luhmann, Jr.</td>
<td>Quasi-Optical Circuits for the 80-400 GHz Band</td>
</tr>
<tr>
<td>Electrical Engineering, UCLA</td>
<td>MSM and Plasma Physics</td>
</tr>
<tr>
<td>Prof. D.H. Marin</td>
<td>Far-Infrared and Millimetre-Wave Spectroscopy</td>
</tr>
<tr>
<td>QMC, London</td>
<td>The Gyrotron or Electron Cyclotron Resonance Maser</td>
</tr>
<tr>
<td>Prof. S.M. Hamberger</td>
<td>Far-Infrared and Submillimetre Astronomy in Australia</td>
</tr>
<tr>
<td>Plasma Res. Lab., ANU</td>
<td>Trends of Millimetre Wave Research in the US</td>
</tr>
<tr>
<td>Dr. C.H. Burton</td>
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<tr>
<td>CSIRO Div. of Appl. Phys.</td>
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<td>Lindfield NSW</td>
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<tr>
<td>Dr. G.F. Brand</td>
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<tr>
<td>Plasma Physics,</td>
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<tr>
<td>Uni. of Sydney</td>
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<tr>
<td>Dr. I.W.V. Storey</td>
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<tr>
<td>Physics, University of NSW</td>
<td></td>
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<tr>
<td>Dr. A. Tirkel</td>
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<tr>
<td>RMIT, Melbourne</td>
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Artificial intelligence moving in

Engineers who think their knowledge, experience and expertise could not be replaced by a machine should beware of 5th generation computers. This is the message of Australian computer scientists involved in developing 5th generation software.

New programs called expert systems will be able to function like engineering consultants — hence the name expert — said Assoc Prof John Gero, director of the department of architectural science's computer applications research unit at Sydney University.

Engineers' knowledge and experience will be packed into computer programs and will be for sale like a commodity, he said.

Expert systems are no longer procedural programs telling a computer to carry out certain procedures such as numeric calculations. They are systems capable of analysing what procedures should be taken, which has generally been the engineers' realm.

Expert systems are rapidly growing subarea of artificial intelligence. They can explain their reasoning and why they arrive at certain conclusions. They can defend their results which means their knowledge is open to scrutiny.

"We could expect to learn from an expert system in the same way we learn from dialogue with a specialist consultant," Gero said.

Already there are several established expert systems, such as the Mycin program for medical diagnosis, Dendral for interpreting mass spectrometry in chemistry and Prospector for geological prospecting. Many other areas like electronic system fault detection, architectural space planning and truck engine maintenance are now being added.

In Australia no expert system has yet been used commercially, but research and development is going on in a number of places.

Gero's unit is working on developing expert systems for computer graphics, drafting systems and building design. Of CAD systems, he said an expert system could determine which working drawings need to be done to provide sufficient information for a builder to construct a building.

Similarly, based on a knowledge of the building and what is represented in the drawings, an expert system could determine what should be in the specifications.

The NSW Institute of Technology's school of computing sciences is also very active in 5th generation computing.

One of its projects, developed in conjunction with the St Vincent Hospital's Garvan Institute of Medical Research, is an expert system that will diagnose endocrinological disorders. Fed with blood test results, doctors' comments and patient details it will write consultant-level laboratory reports including diagnostic comments.

The first part of the project which is jointly supervised by the school's head, Dr Ross Quinlan, and the Garvan Institute computing science unit's manager, Dr Paul Compton, is about to be deployed. It concentrates on the thyroid gland.

The next step will be its application to other endocrinological areas. Compton said the system has been designed to be able to start working with a rough set of facts and knowledge and learn from each case it deals with.

Subsequently the system will be applicable to any other biochemistry area, Compton said.

Another project is developing a trouble-shooting expert system for diagnosing faults in computer disc drives. It will be able to tell a service engineer what is wrong with a customer's disc drive. The project, carried out in cooperation with Honeywell, is now at the prototype stage.

The school's two major theoretical projects are developing new architectures for reasoning with uncertain information and applying logic programming
techniques to systems design.

About a year ago Dr John Debenham, principal lecturer and director of the school's Centre for Graduate Studies, set up an informal 5th generation study group which gathers and exchanges information on the topic and aims at making and fostering connections with overseas research groups.

The term 5th generation applies to totally new concept of computer software and hardware. The software is based on symbolic rather than numeric languages. It uses declarative instead of the procedural representation all previous generation programs are based on.

An expert system consists of acquiring, representing and manipulating knowledge. This process is called knowledge engineering. In principle the problem works according to the basic logic pattern: if this is true then that must be true. Such logic inferences are made from a variety of facts stored in a facts base and another information source called knowledge base.

In contrast to 4th generation databases, facts and knowledge bases can be added to and subtracted from without affecting the program. It operates with any number of facts and has no beginning or end. The knowledge is explicitly embodied in the program and the user can evaluate it and check its correctness at any time.

4th generation programs entail knowledge implicitly. It is woven into the program and cannot be extracted by the user.

That means any change of facts or knowledge requires major rewriting of the program.

While it is possible to write logic inferences programs in 4th generation languages such as Fortran, Basic, Pascal or Ada, it is cumbersome. Therefore symbolic programming languages have been and are being developed. Expert systems have been written in many types of languages, the major ones being Prolog and Lisp.

5th generation computer hardware consists of three basic parts: a knowledge and facts base, an inference machine and a user-machine interface.

Research and development of 5th generation hardware increased dramatically when Japan launched its 5th generation computer development project two years ago, followed by similar efforts in the US.

Earlier this year Japan's Institute for New Generation Computer Technology completed the design of a sequential inference machine. A parallel inference machine is now in its basic research stage.

5th generation computer hardware breaks away from the traditional von Neumann design, introduced in the late 1940s by John von Neumann, a Hungarian-born mathematician.

Although since then the capacity and speed of computers has increased immensely, their basic scheme of operation — their architecture — has not changed from von Neumann's concept.

In this concept the computer executes each calculation in a sequence of single steps, one at a time, storing each result in its memory before moving on to the next calculation. With increasing speed requirements this von Neumann architecture has become what is called the "von Neumann bottleneck" which limits the speed existing computers can achieve.

To break this bottleneck computer scientists have departed from von Neumann's concept and are developing new machines with many processors and shared memories, enabling the machine to execute many instructions simultaneously. The processing speed of these "non-von Neumann" architectures increases dramatically and makes the hardware suitable for the demands artificial intelligence programs put on them.

The four computer generations up to now were marked by the following technological advancements.

The 1st generation started with the Electronic Numerical Integrator and Computer (ENIAC) built at the University of Pennsylvania and completed in 1946. With the Electronic Discrete Variable Automatic Computer (EDVAC), devised by John von Neumann and built a year later, binary notation and stored internal programming were introduced. These 1st generation computers depended on thousands of thermionic valves which are complex and expensive to produce, were large, needed high-voltage input and generated considerable heat.

2nd generation computers were made possible by the invention of transistors replacing thermionic valves at a fraction of cost, size, energy use and heat generation. In the 1960s the development of integrated circuits which now contain up to 200,000 components per cm² started the 3rd computer generation.

The breakthrough toward the 4th generation was made in 1971, when the first microprocessor was built. It was smaller than a fingertip and 20 times faster than ENIAC.

Dietrich Georg, Engineers Australia

International Conference Progress in Optical Physics

The conference Progress in Optical Physics is to be held at University of Melbourne 15-17 August 1984 as a satellite meeting of ICO13 to be held in Sapporo, Japan. The Melbourne meeting is sponsored by the International Commission for Optics, the Australian Academy of Science and the Australian Optical Society.

The theme of the conference is wide-ranging with coverage of the latest developments in astronomical optics, optics of thin films, fibre optics, Fourier optics and imaging and nonlinear optics.

A topic expected to be of intense interest concerns progress in optical computing. To stimulate this discussion the program committee has invited A. Huang of Bell Labs, U.S.A., to speak on "The All-optical Computer" to be followed by R.W. Kyes, IBM, USA., on "Why Optical Computers Have No Chance", J.W. Goodman of Stanford University, U.S.A., will add to the argument with his contribution "Optical Computing with High Numerical Accuracy". This debate promises to be a major conference highlight.

Other invited speakers include T. Yoshino, University of Tokyo, Japan, on Optical Fibre Sensors and J.D. Love, Australian National University, on Propagation in Single-Polarization Fibres. R.P. Shannon of the Optical Sciences Center, U.S.A., will talk on Astronomical Optics while M.D. Waterworth, University of Tasmania, is to talk on the Starlab Spectrograph. Further invited contributions are on Optical Design, W.T. Welford, Imperial College, U.K., New Applications of Monocentric Systems by J.M. Burch, National Physical Lab, U.K., and Wave Optics with Particles by A.G. Klein, University of Melbourne.

An invitation to attend the conference is extended to anyone actively engaged in optics research, the teaching of optics, members of the optical industry and others with an interest in optics. Further details may be obtained from the Chairman of the Local Organising Committee, Dr I.J. Wilson, CSIRO, Division of Chemical Physics, P.O. Box 160, Clayton, Vic. 3168.

The Australian Physicist, Vol. 21, May 1984 — Page 92
LETTERS

Gentlemen:

This letter will bring to your attention some of the activities of the American Physical Society’s Forum on Physics and Society. Perhaps one of the most timely and important of them is a series of studies on Nuclear Arms Control, which is described briefly in the following item from the April 1983 issue (Vol. 12, No. 2) of the Newsletter of the Forum.

If your Society is engaged in similar activities we would like to hear of them. We suggest that you submit a brief account of your activities for possible inclusion in the Forum Newsletter. Copy for such publication should be sent directly to the editor of the Newsletter:

John Dowling
Physics Department
Mansfield State College
Mansfield, PA 16933, USA.

This same material, along with any additional literature should be sent to:

Eric Fawcett
Physics Dept.
University of Toronto
Toronto, M5S 1A7, CANADA.

We would like to invite your members to join the APS or to subscribe to the Forum Newsletter. Members of the APS are not required to pay an additional fee for membership in the Forum.

A subscription to the Newsletter “Physics and Society” is available to non-members for a fee of $4.00 (Canada) or $5.00 (overseas).

W.W. Havens, Jr.
The American Physical Society,
335 East 45 Street, New York, NY, 10017

FORUM STUDIES ON NUCLEAR WEAPONS, ARMS CONTROL AND DISARMAMENT by Leo Sartori, Univ. of Nebraska, Lincoln, NE 68588.

The July 1982 issue of Physics and Society contained a call for volunteers to participate in a FORUM sponsored program of studies related to nuclear weapons, arms control and disarmament. A similar letter appeared in Physics Today in August.

In response to these calls nearly 100 individuals have volunteered. The steering committee has organized five groups to carry out feasibility studies which will, we hope, lead to full fledged studies. The topics under consideration and the coordinators of corresponding study groups are as follows:

1. Vulnerability — this is a merger of the topic previously called “biased errors — windows of vulnerability and reliability of large scale systems.”
   Coordinator: Peter Zimmerman, Louisiana State University, Baton Rouge, LA 70803.

2. Verification — Coordinator — Dietrich Schroeter, University of North Carolina, Chapel Hill, NC 27514 (919-962-3019).

3. Proliferation — Coordinator — Dr. L.C. Hebel, Xerox, Palo Alto Research Centre, Palo Alto, CA 94304.


Each of the five groups is at work and progress reports will be presented at the Baltimore Meeting in April. Following the reports there will be an open discussion on plans for a future course for the program, including a possible get-together during the summer. In addition to the five group studies, we have organized a working group on “international Physics and Arms Control” under the leadership of Eric Fawcett, University of Toronto, Toronto, Ontario M5N 1X5.

I am pleased to report the APS Council has expressed its strong support for our project and has allocated a small sum to cover incidental expenses for feasibility studies. It is not too late for interested individuals to join study groups. If you are seriously interested in participating, please contact the appropriate coordinator directly, with a copy to me.

If you responded to my initial call but have not been assigned to a study group, it is because the topics which you expressed interest in did not elicit sufficient response to constitute a “critical mass” in the judgement of the steering committee. You are welcome to join one of the existing groups if you wish.

* * * * *

Dear Sir,

In an examination in medical physics the following spellings were recorded in connection with a question on fluid flow. Is this a record?

| Pouissolles | Poiisselles |
| Poisegules | Poiseegules |
| Poissoules | Poissuules |
| Poisouilles | Poisouilles |
| Poiisouilles | Poiisouilles |
| Poiouilles | Poiouilles |

W. W. Havens, Jr.
The American Physical Society,
335 East 45 Street, New York, NY, 10017

FORUM STUDIES ON NUCLEAR WEAPONS, ARMS CONTROL AND DISARMAMENT by Leo Sartori, Univ. of Nebraska, Lincoln, NE 68588.

The July 1982 issue of Physics and Society contained a call for volunteers to participate in a FORUM sponsored program of studies related to nuclear weapons, arms control and disarmament. A similar letter appeared in Physics Today in August.

In response to these calls nearly 100 individuals have volunteered. The steering committee has organized five groups to carry out feasibility studies which will, we hope, lead to full fledged studies. The topics under consideration and the coordinators of corresponding study groups are as follows:

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   Coordinator: Peter Zimmerman, Louisiana State University, Baton Rouge, LA 70803.

2. Verification — Coordinator — Dietrich Schroeter, University of North Carolina, Chapel Hill, NC 27514 (919-962-3019).

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| Poisegules | Poiisselles |
| Poissoules | Poissuules |
| Poiisouilles | Poiisouilles |
| Poiouilles | Poiouilles |

J.R. Prescott
Elder Professor of Physics

According to my dictionary, the correct spelling does not occur in this list, unless it is permissible to omit an apostrophe. Ed.
maximise the possibility of the former of these and encourage informality and a contact not available in large group sizes. We are not talking here of producing a grand spectacular, simply providing communication and a learning experience not generally available to school students.

The AIP suggests that volunteers should contact their Branch Committees by August. State/Territory Coordinators of ASISW would then be asked to match by locality, physicists with schools desiring to participate in the venture. Arrangements as regards visit times and locations can then be negotiated between the school and the member of the Australian Institute of Physics.

I believe that the Speakers Scheme is well worthy of your consideration, as it provides a service that has been greatly lacking in the past. It is also possible that the students to which your members speak may well be persuaded to become the physicists and Institute members of the future.

Would all those interested please act on this letter.

D. Hyatt,
The Australian Science Teachers' Association
P.O. Box 26, Highett, Vic. 3190

AUSTRALIAN SCIENCE IN SCHOOLS WEEK
15th-19th October 1984

The Australian Science Teachers' Association in conjunction with your own State/Territory Science Teachers' Association is proud to announce the inaugural Australian Science in Schools Week to be held in the week 15th-19th October 1984.

Teachers and students in both Primary and Post-primary Schools throughout Australia are invited to participate in special events during this week.

- to focus community attention on science and its importance in the school curriculum
- to promote the image of science
- to involve students in a broad range of science-related activities
- to promote science as being fun.

Participants

Anyone who has an interest in science. Students in primary or post-primary schools, teachers, professional scientists. It is hoped that the broadest range of students possible will be assisted in their school-based activities by teachers and scientists alike.

Activities

- displays, project work, presentations by students within the school
- open days/evenings when the community can visit the local school to observe science-related activities
- displays of posters, projects etc. in local stores, libraries and banks
- articles written for local newspapers
- meetings with and talks by scientists.

Dear Sir/Madam,

Would it be possible to place a short note into the Australian Physicist? I am searching for a supply of “toy” gyroscopes that are suitable for presents for young adults (as well as older adults). After searching several dozen stores in Sydney, I have only found a handful of staff who even know what a gyroscope is. The problem, it appears, is that gyroscopes do not contain silicon chips or batteries. Perhaps one of your readers may know of a store that sells them?

Peter E. O'Connell,
P.O. Box 837, Taree, NSW, 2430

PEOPLE

Dr Peter Wood, a Senior Research Fellow at Mt Stromlo Observatory and authority in the field of the structure and evolution of late-type stars, has been awarded the Pawsey Medal for 1984. It is the second year running that a Mt Stromlo researcher has taken out the medal, and the fourth time since it was introduced after 1967.

The medal is normally awarded once a year by the Australian Academy of Science to young scientists for distinguished research in experimental physics.

* * *

Wilfred Odagola of the Ugandan National Research Council and Marion Ritchie from the University of Guyana are working on solar energy applications to crop drying and preservation at the Division of Energy Technology for two months. They have been sponsored by the Commonwealth Foundation.

* * *

R.N. Morse, AO has been made an Honorary Fellow of The Institution of Engineers, Australia for "conspicuous scientific and engineering contributions and pioneering achievements in solar energy throughout Australia and the world".

* * *

Dr. M.F.R. Mulcahy has retired from the position of Assistant Chief, Division of Fossil Fuels, CSIRO. Dr. Mulcahy is presently a Visiting Professor at Leeds University.

* * *

Mid to late 1983 saw several staff changes at Quentron Optics Pty Ltd.

Firstly, Andrew Pfeiffer, a physicist working in sales left to join the Defence Research Centre at Salisbury. Andrew had been with Quentron for four years and wanted to expand his practical experience in an experiment area.

John Holdsworth, a physical chemist/physicist from Griffith University, formally joined the sales and marketing team in July and went overseas for training in September, 1983.

John Holdsworth was previously employed at Quentron in the R & D area for two years during which he built the first gold vapour laser in Australia based on a design concept provided by Professor Jim Piper of Macquarie University. A subsequent prototype has been used at the Queen Elizabeth Hospital in Adelaide for 2 years and has treated about 100 patients.

John's experience will prove very valuable in customer support now that metal vapour lasers are entering the marketing phase. He has also worked with most types of lasers, spectrometers and associated instruments.
Dr. Mike Tristram, an analytical chemist and formerly Quentron's Melbourne Branch Manager, has left the company to join JEOL in Sydney. JEOL is stronger in the analytical instrument field than Quentron and was able to offer greater opportunities for Mike.

As it was not possible to find someone with Mike's experience in Melbourne, the branch has been closed and activities transferred to the Sydney Branch headed by Paul Brady.

Ralph Hahnheuser, a physics graduate from Flinders University joined the company in March, 1984 and is being trained in the laser and electro-optic product range to provide sales support from Adelaide.

An additional five people have been hired in the manufacturing area to produce metal vapour lasers, power supplies and electron backscatter detectors. As the R & D phase of some products is reaching completion, the emphasis in staff requirements has been to engineering and technical staff.

The company has a backlog of gold and copper lasers to produce and expects shipments to start in June, 1984. An export sales drive is expected to increase this backlog and provide further growth.

* * *

The following were elected to office in the NZ Institute of Physics for 1984:

President: Professor R.L. Dowden, Otago.
Vice-President: Dr. G.D. Jones, Canterbury.
Secretary: Mr. K.R. Dawber, Otago.
Treasurer: Dr. J.N. Hodgkinson, Otago.
Council: Professor R.E. White, Auckland; Dr. D.N. Pinder, Massey; Dr. R. Sherlock, Waikato; Dr. J.F. Clare, Wellington; Dr. P.H. Butler, Canterbury.
Education Committee: Dr. S. Whineray, Chairman.
New Zealand Physical Editor: Dr. J.L. Bahr.

* * *

The Managing Director of SIROTECH Ltd, is Mr Julian Doyle, a Melbourne businessman.

Mr. Doyle established the Victorian Development Corporation and was its first Chief Executive. He is a lawyer by profession, has served as Trade Commissioner in Europe and Africa and recently attended the OECD Conference on High Technology as an Australian Delegate.

Mr. Doyle is the second appointment to the SIROTECH company. Mr. Lindsay Cuming was appointed late last year as Chairman of the company.

SIROTECH Limited is the joint venture company aimed at increasing industry's use of CSIRO research results.

* * *

Dr. A.G. (Tony) Klein recently accepted a personal chair in the School of Physics of the University of Melbourne.

Tony Klein, who originally trained as an electrical engineer, spent the initial part of his career as a research scientist at the A.A.E.C. (Lucas Heights) as well as at Oak Ridge and Argonne National Lab. in America. He joined Melbourne University in 1963, where he worked on solid state physics, high energy physics, and problems of advanced instrumentation. More recently, he has gained an international reputation for his work on neutron optics carried out at Lucas Heights, the University of Missouri (Columbia), and the Institut Laue-Langevin in Grenoble. Some of these experiments he carried out were directed to the advancement of the optics of neutrons per se, and some were directed to testing the foundations of quantum mechanics. His present interests include both conventional and "alternative" optics addressed equally to fundamental and applied physics.

Tony Klein is a great wit, a brilliant lecturer, and a formidable spokesman for physics in particular, and science as a whole. He is to be congratulated on the receipt of his well-deserved chair.

Geoffrey I. Opat

The following ideas on lecturing come from the University of Melbourne Gazette:

Tony Klein believes that lectures should be an intellectual adventure, and has spent 18 years sharing his enthusiasm for his subject with students.

His method of lecturing is to put himself in the shoes of the student and to remember his own undergraduate days when he attended countless lectures.

He believes the lecturer must start with some preconceptions of the ability and knowledge of students and these change as the lectures proceed.

"You take your cues from the students. You observe their faces," Dr. Klein said.

"In a large class there are a few reference candles. You watch their faces and keep explaining until those faces light up and finish explaining when you think you have got most of them.

"I enjoy presenting problems as an intellectual challenge and working through the solution pointing out the cunning bits."

Astronautical Society

Anyone with an interest in space science or technology is welcome to subscribe to the News Bulletin of the Astronautical Society of Western Australia. I can highly recommend this very full and up-to-date monthly, which costs $6 and can be obtained from P.O. Box 273, Gosnells, 6110. Those resident in Western Australia might like to request membership in the Society.

Ed.

The Australian Physicist, Vol. 21, May 1984 — Page 95
ESSAY REVIEW

MACROPHYSICS AND GEOMETRY, A.H. Klotz, Cambridge Univ. Press, Cambridge, 1982 xiv + 152pp., $52.00

Reviewed by P. Szekeres, Dept. of Mathematical Physics, University of Adelaide.

In his later years Einstein devoted most of his creative energies to the problem of finding a unified field theory of gravitation and electromagnetism. Unable to come to terms with the directions physics had taken in the late 20's and 30's he returned to the kind of thinking which had resulted in his magnum opus, the general theory of relativity. It's hardly surprising. Anyone who has come to master this theory is forever under its spell. There is something so clean, so compelling in the theory, that by comparison the complex threads of quantum theory, with all their interpretational ambiguities, appear as a disconnected sequence of ad hoc ideas. Yet general relativity remains, by its very nature, a closed theory. It describes gravitation, no more no less, and entirely in classical terms. There are no untied ends where other fields can attach themselves, far less where the entire theoretical framework of quantum mechanics can find a natural place. But if gravitation can be understood so beautifully in geometrical terms, then surely at least that other classical field theory, Maxwell's electromagnetism, must be capable of a geometrical interpretation.

The weaving of that magical tapestry of geometry and physics which we call a unified field theory had been attempted by a number of people. The most famous were the gauge theory of Weyl and the 5-dimensional theory of Kaluza and Klein. Both these theories have had something of a revival in recent years. Weyl's theory in particular can be regarded as the forerunner of the current maze of gauge theories which show much promise of unifying not only electromagnetism and gravitation but the weak and strong fields as well. The path Einstein himself took was, if anything, more pedestrian. He reasoned somewhat as follows. General relativity shows that gravitation must be described by a symmetric metric tensor field $g_{\mu\nu}$ having 10 independent components in four dimensions. Electromagnetism on the other hand is represented by a skew-symmetric tensor having 6 independent components. Can the two be combined naturally in a single object having 16 components? The most obvious candidate is a non-symmetric metric tensor field $g_{\mu\lambda}$, whose symmetric part is to represent gravitation while the skew-symmetric part becomes identified with the Maxwell tensor. The problem then becomes to write down mathematical equations which lead in appropriate limits separately to general relativity and Maxwell's equations yet in their total generality area fusion of the two with possible new consequences in some physical regime yet to be investigated. The idea is simplicity itself, yet Einstein grappled with it for over twenty years. He was never to achieve a satisfactory solution, and the general verdict is that on the whole he was wasting his time, that the whole search was not only fruitless but probably pointless and ill-conceived, and that the old master had just simply lost his touch.

Now suddenly, nearly thirty years after Einstein's death, there appear two books both taking their inspiration from the work of his later period. The two books, both written by individualists working outside the mainstream of current research, remain in very different paths yet it is worth considering them together because of this common thread of motives and ideas. Klotz's book takes the Einstein theory, particularly the form adopted by Einstein, and Straus, fairly literally. However new life is breathed into what most people would regard as a fairly dead horse, by some interesting reinterpretations. Klotz regards Einstein's identification of the electromagnetic field with the skew part of the non-symmetric field $g_{\lambda}$ as very ill founded.

Indeed once one thinks about it the whole idea is crazy. The symmetric $g_{\mu\lambda}$ are potentials for the gravitational field needing two derivatives to produce gauge-invariant field quantities (curvature tensor). If hardly seems feasible to combine these into a single object with the gauge-invariant Maxwell field. Klotz proceeds to examine some of the most significant arguments against the Einstein theory in detail. These mostly centre around the inability of the theory to reproduce the Lorentz force law in the appropriate approximation on the basis of the Einstein-Infeld procedure. His analysis then digs up new candidates for the electromagnetic field which do yield the correct Lorentz equation. These candidates are of course considerably more complex than Einstein's original proposal. Even more radically, Klotz suggests that the metric need not be identified with the symmetric part of the $g_{\lambda}$. The final theoretical structure which emerges is a bit open-ended and incomplete, but what Klotz has successfully shown is that with an appropriate reinterpretation there is life in the old ghost yet. This is a well written book, technically a little hard to follow in parts, but in all a fascinating and novel addition to an area in which the literature is very sparse and has been devoid of any fresh ideas for decades. There is a pleasant personal style running through the book, and the author seems to have been blessed over the years with some very capable research students whom he generously acknowledges.

Mendel Sachs's route is quite different. His debt to Einstein is in spirit only. To introduce an object with 16 components Sachs abandons the standard metric

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu$$

as the basis of his geometry, and instead he writes a one-form $q_{\mu}$, $dx^\mu$. However this is no ordinary one-form for its components $q_{\mu}$ are each of them quaternions (shades of Hamilton!) and in this way the magical number 16 arises. Now quaternions are a wondrous thing, for in them the structure of the rotation group and even the Lorentz group finds natural representations. Spinors pop up for the asking and a metric of the right signature is easily constructed by setting

$$g_{\mu\nu} = -\frac{1}{2} (q_{\mu} q_{\nu} + q_{\nu} q_{\mu})$$

where $q_{\mu}$ is the conjugate quaternion. When finally (in chapter 6) Sachs derives the field equations, Einstein and Maxwell both arise, but as in Klotz's theory the identification of the Maxwell tensor is no trivial matter. A crucial part of the argument appears to be chapter 4, where some important properties of the matter field equations are derived. I had a lot of difficulty with this chapter understanding exactly what was going on.
Mendel Sachs writes down some Dirac-like spinor equations arising naturally in his quaternionic variables. He then tells us that the mass parameter is to be treated not as a constant but as a field variable, that when general relativity is applied to the situation this mass parameter is always present and depends on the curvature of the space-time produced by the rest of the universe. In this way Mach's principle finds its way into his scheme of things. Attractive as this all is I could see no logical progression of ideas which led so inexorably to this conclusion. Sachs continues even further to show that in the strong coupling limit a quantum mechanical eigenvalue structure emerges with mass eigenvalues appearing in pairs. In the concluding chapter of the book a cosmological argument leads to the tentative proposal of the electron-phonon pair as a typical mass doublet predicted by the theory, the mass ratio appearing in terms of the fine-structure constant in a previously recognized but hitherto unexplained way. Again, this is a fascinating book. It is more adventurous than Kloetz's book, and really sets out to shake up the whole of physics. A lot of the arguments and some of the mathematical ideas are attractive, but Mendel Sachs is like a magician pulling out one bunny after another from his hat and you are just left wondering in amazement where they are all coming from.

Chapter 3 emphasises the geometrical nature of gauge fields in the context of differential forms, fibre spaces and topological properties; solitons again figure prominently as do the electromagnetic and gravitational fields.

The final Chapter 4 concerns quantum aspects; I particularly liked the treatment of constraints and their inclusion in the path integral formulation. Ghost fields in Yang-Mills theory and gravity are shown to be necessary, following naturally the choice of gauge; the detailed exposition of the first order Feynman rules and quantum invariance in gravity is an especially welcome feature of this chapter. Finally there is a mention of vortex solutions.


This large and advanced text concerns condensed-matter applications of many-body theory but excludes, for example, nuclei. The level is beyond that of a normal Honours course, the intended audience being (American) third- or fourth-year graduate students.

Chapter 1 very briefly summarizes some basic solid state theory, while chapters 2 and 3 present the Green-function diagrammatic theory of electron-electron, electron-phonon and (nonrelativistic) photon physics, for zero and non-zero temperature respectively. Kubo linear response theory is often used, though, curiously enough, it is never expounded in full generality. The level of explanation in chapters 2-3 is mostly somewhere between that of the standard texts by Abrikosov et al. and Fetter and Walecka on one hand, and the more qualitative book by Mattis on the other. A beginning graduate student will probably need to refer to these other texts as well.

The main strength of this book lies in the advanced applications given in chapters 4-10. Soluble systems such as the Luttinger model are discussed at length. The electron-gas chapter goes further than most, discussing for example the Hubbard and Singwi dielectric function as well as the more usual RPA version. Polarons and excitons are treated in some detail, as are optical properties of solids, superconductivity and liquid helium. Current topics treated here, such as X-ray absorption edges, superfluid 4He and tunneling in superconductors, are probably expounded elsewhere only in the research literature or in highly specialized monographs. Adequate reference lists and problem sets accompany each chapter.

A.D. SAKHAROV — COLLECTED SCIENTIFIC WORKS, D. ter Haar, D.V. Chudnovsky, & G.V. Chudnovsky, Marcel Dekker, New York, 1982, xvi + 303pp., $US27.50. Reviewed by D.B. Medrose, School of Physics, University of Sydney.

It is unusual for the collected papers of a scientist to be published while he is still alive (and publishing) and all the more unusual when the scientist himself is of at least as much interest as his scientific works. Andrei Sakharov is a prominent Soviet physicist who is best known for his activities in the human rights and peace movements. These activities led to the award of the Nobel Peace Prize in 1975 and to his falling from favour with the Soviet establishment to the extent that he is now in internal exile in the city of Gor'kii where his health is now causing serious concern. This book of

The Australian Physicist, Vol. 21, May 1984 — Page 97
Sakharov’s collected works differs from most collections of papers in several respects, reflecting the unusual reason for interest in his works. Comments by Sakharov himself are included both as introductions to each group of papers and in the form of notes and remarks on particular papers. There are also commentaries by specialists in relevant fields, and these are of considerable assistance to the interested reader in assessing the significance of Sakharov’s scientific work. In addition there is an autobiographical note, and the citation and lecture for the Nobel Peace Prize are included in full.

Twenty papers are included and these are divided into three parts: plasma physics (5 papers) with the commentaries by H.P. Furth and T.H. Stix, cosmology (8 papers) with commentaries by J.D. Bjorken, J. Illiopoulos and L. Susskind, and field theory and elementary particles (11 papers) with commentaries by S.L. Adler and H.L. Lipkin. There is also a fourth part called “Divertissements” which includes twelve short items. These range from an algorithm for calculating the Fibonacci series to the statistical properties of polygons obtained by slicing a cabbage.

Sakharov’s work in plasma physics was mostly in the 1950s and is strongly directed towards the problem of controlled thermonuclear fusion. He is credited with the first proposal for a toroidal plasma device, which led to the current tokomak machines. He also made suggestions for obtaining ultrasonic magnetic fields (magnetic confinement) and for the catalysis of nuclear reactions by Mu mesons. His main achievements in the fields of cosmology and elementary particles are CP violation and the baryon asymmetry in the Universe, induced gravitation (the hypothesis of the zero-point Lagrangian of the gravitational field), mass formula for quarks, mesons and baryons and the hypothesis of the reversal of the arrow of time and the multi-sheet cosmological model of the Universe. He began publishing these ideas in the mid 1960s and continues to do so; the latest papers included in the collection were published in 1979 and 1980.

The impression I gained from reading this collection is that of a highly imaginative theoretical physicist whose ideas were often ahead of their time. He has made major contributions in several fields; however he has not become the leading world expert in any particular field.

What of his more controversial role in the development of nuclear weapons? I quote his own words:

“In 1948 I was included in Tamm’s research group which developed a thermonuclear weapon. I spent the next twenty years continuously working in conditions of extraordinary tension and secrecy, at first in Moscow and then in a special research center. We were all convinced of the vital importance of our work for establishing a worldwide military equilibrium, and we were attracted by its scope.”

and

“In 1953 I was elected a member of the U.S.S.R. Academy of Sciences. My social and political views underwent a major evolution over the fifteen years from 1953 to 1968. In particular, my role in the development of thermonuclear weapons from 1953 to 1962, and in the preparation and execution of the thermonuclear tests, led to an increased awareness of the moral problems endangered by such activities.”

He then describes how he became involved in the human rights and peace movements, his falling from favour and his banishment “to Gor’kii, where I am virtually isolated and watched day and night by a policeman at my door.”

This book is well presented and is a fitting tribute to a very capable theoretical physicist and an outstanding human being.


This upper school physics text follows successful publication by the same author of a set of three lower school science texts. He is well respected in W.A. by science teachers as a founder member of the Science Teachers’ association of Western Australia (S.T.A.W.A.), an organisation which publishes many science books which have enjoyed good sales. Further he is a practising teacher so is very familiar with the curriculum and appropriate levels of its presentation.

It is no surprise then that Fundamental Physics is well suited to the West Australian Tertiary Examination syllabus. The chapters are short and follow in sequence an accepted Year 11, year 12 teacher pattern. Each chapter includes questions, colour coded, and a major ideas section at the end of each chapter. Answers to text questions do not seem to have been included. The diagrams and illustrations are clear and well presented. Worked examples for typical problems are also sensibly included.

This textbook is conservative in its approach and therefore is in competition with several other texts. For West Australian teachers it is particularly appropriate and with their knowledge of John Anderton, I feel its sales are assured. In this state at least he is on firm ground. At $20 it presents good value in today’s world of expensive school text books.


This text book has been written specifically for the U.K. ‘O’ level Physics course and has attempted to relieve some of the mathematical nature of the course by "pie diagrams" and analogues where possible.

In his presentation, Mr. Rivett has decided to include suitable projects, class experiments, theory section and topic major points all on the same page, which makes the text complete, yet difficult, to follow.

Reviewing this book was hindered by only Part I being available. The book was not suited to the West Australian University Examination Entrance Syllabus. It is heavily biased to the mechanics topics which are covered in far to much detail. The Atomic structure section would be more suited to our Chemistry course. The Waves Section only briefly mentioned refraction and did nothing to emphasize how the theme of wave theory can find application in many branches of physics.

Overall this book does not suit our syllabus requirements. Its level of readability was poor; but I admire Mr. Rivett taking up the challenge of the mathematical problem many students have with physics and his attempt to relate abstract concepts in physics to more familiar situations.
Looking for the edge of the universe

Early last year a team of Australian and British astronomers concluded that the universe is a little bit larger and a little bit older than previously thought. They reached this conclusion when they detected an object that may be 18 billion light years — that is $17 \times 10^9$ km — from earth. It’s the most distant object found as yet, and it’s moving even further away from us at close to the speed of light.

The discovery came just 50 years after a chance finding that led to a revolution in astronomy. During 1932, a Bell Laboratories scientist was trying to track down sources of interference in trans-Atlantic telephone connections. When he pointed his antennae at the sky, it became obvious that the Milky Way itself was one source of interference. It seemed that our earth is constantly bathed in radio noise, and a new tool for probing the mysteries of our universe — the radio-telescope — had been discovered.

World War II broke the pace of development, but research into radar and electronics had direct application to radio-astronomy, and in the post-war years scientists incorporated the new technology into radio-telescopes constructed in Australia, the United States, Britain, and Europe.

One of the many sources of radio noise discovered in the early fifties, by astronomers at Cambridge in England, took the code name 3C48 (because it was No. 48 in the third Cambridge catalogue). This object languished unremarked until 1960, when a California Institute of Technology group led by Dr John Bolton, formerly with the CSIRO Division of Radiophysics, obtained an accurate ‘fix’ on its position in the sky.

When the giant Palomar 200-inch optical telescope looked at the part of the sky containing 3C48, the object appeared to be a star. This was the first time such a coincidence had been found; previously all sources of radio noise had been associated with large objects such as galaxies or supernova remnants.

One of the first of the quasars discovered — 3C273. A long jet can be seen at the bottom right.

Another surprise was the 3C48, when the telescope recorded its spectrum, was found to be unlike any other star that had been investigated. It had an excess light at the blue end of the spectrum, which could not be explained with the then-current knowledge. Half a dozen similar objects were uncovered in the next few years and still no sense could be made of their unusual spectra.

It was only in 1963 that Dr Maarten Schmidt, at Palomar, made the great intuitive leap. After a very clear night’s viewing he was puzzling over an excellent spectral analysis of the light from 3C273 when he wondered what would be the case if these objects were showing an unusually large redshift. Suppose that 3C273 was very far from us and its spectrum had been shifted a long way towards the red end of the spectrum: could the various spectral lines of 3C273 fit into such a scheme?

They did! For example, he found that the very strong ‘Magnesium II’ peak, associated with ionized magnesium atoms and normally found in the ultra-violet, had been shifted 16% into the blue part of the spectrum. The clear conclusion was that these objects were much further away then even the most distant galaxies known at that time.

And another puzzle arose; those galaxies were extremely faint — at the limits of the resolving power of the big telescopes — yet here were clearly visible objects billions of light years further away. Huge amounts of energy must be expended if their radio and light waves could reach us. As they looked like stars but obviously weren’t, the term ‘quasi-stellar radio source’, or quasar, was applied to them.

Once the astronomers knew that these strange objects displayed strong redshifts they found them easier to detect. One early trick was to compare photographs of the sky using photographic emulsions slanted towards the blue and ultraviolet end of the spectrum. The quasars are strong in the ultraviolet region and, by this means, many more quasars were detected. It soon became obvious that not all quasars emitted radio signals — only about one in eight of the blue ‘stars’ had any radio emissions associated with it.

Using very long baseline interferometry — where radio-telescopes separated by thousands of miles work as one — radio-astronomers soon established that quasars were, in cosmological terms, very small objects. A typical quasar occupies a volume only a few light years across — but from this relatively small volume the energy of a billion suns radiates into space. Neither nuclear fission nor nuclear fusion could explain such a prodigious output, adding one more facet to the quasar enigma.

Searching the southern sky

Dr Bolton rejoined CSIRO and from 1966 worked with Dr Bruce Peterson, from the Australian National University’s Mount Stromlo Observatory, in the search for more quasars. Using the Parkes radio-telescope for some identifications and the blue photographic emulsions for the ‘radio-quiet’ quasars, they discovered more than 100 quasars in the next 5 years. These included the quasar with the then-record redshift of 2 — a redshift implying that the light from it began its trip more than 13 billion years ago.

Apart from the intrinsic curiosity surrounding these strange objects, a powerful motivating influence in the search was the desire to find ever more-distant objects. And slowly the records crumbled — the distances being pushed up and up until what appeared to be the limit, a redshift of 3, was reached.

Most of the known quasars — we now know some 1500 of them — are found at redshifts of around one to three. This corresponds to a distance of between 5 and 15 billion light years and implies that we are looking back at what the universe was like soon after its
formation. Perhaps there was nothing more to see!

Then in 1973 a group of American astronomers got an accurate radio position for a new quasar, analysed its spectrum, and announced a new record. This quasar, with a redshift of 3.53, was more than 15 billion light years from earth and moving away from us at 91% of the speed of light. However, it differed from most other quasars; its large redshift had caused a change in its colours, so it no longer had any blue or ultraviolet excess to distinguish it from the billions of other faint stars in the sky. Clearly, such quasars can only be found with optical telescopes if their radio positions can be located very precisely, to within a few arcseconds.

An Australian attempt

Despite major advances in the technology behind radio- and optical astronomy, that record stood until March 26 this year. It was only broken because in 1975 an Australian group — including Dr Peterson, Dr Ann Savage from the Royal Observatory in Edinburgh but based at the United Kingdom Schmidt Telescope Unit near Coonabarabran, N.S.W., and Dr David Jauncey and Dr Alan Wright, from the CSIRO Division of Radiophysics — realized that they would have to refine their approach in searching for these far-distant objects and get extremely accurate positions.

This was where the Tidbinbilla interferometer came into the picture. The scientists — along with Dr Mike Batty, also from CSIRO, and Dr Sam Gulkis from NASA’s Jet Propulsion Laboratory — used the two NASA Deep Space Antennae at Tidbinbilla, near Canberra, to obtain positions accurate to within a few arcseconds for a number of quasars. When they combined these with a selection of quasars from the Parkes catalogue that coincided with very faint objects, the group had a total of 40 quasars that could provide a new record.

It takes about an hour’s observing time on the Anglo-Australian Telescope near Coonabarabran to position, lock onto, and then analyse the light from a faint quasar, star, or galaxy. The first night of observing, in November 1981, produced nothing of consequence. The second night, March 25, 1982, looked as if it would go the same way, especially when around midnight clouds and misty rain settled over the area and completely obscured the view. Then, just before dawn on the 26th, the clouds began to disperse and some patches of clear sky appeared.

The telescope was positioned and the spectrograph began its analysis of the light from the quasar located in the constellation of Sagittarius.

As soon as the light from the quasar, code-named 2000-330, began to appear on the video display, the astronomers watched the spectral analysis intimately. A convenient market for their purposes was the strong emission line from the night sky. If the prominent peak in a quasar’s spectrum, the Lyman alpha line, coincides with this line, the quasar’s redshift is 3.58. When the Lyman alpha line from 2000-330 appeared on the righthand side of this, they knew they were looking at a new record. The final result was the identification of a quasar with a redshift of 3.78, a figure that implies that the object is 18 billion light years away and moving further away at 92% of the speed of light.

In total, the members of the Australian group have found six new quasars with redshifts greater than 3 and expect to find more. When they catch traces of energy coming from those distant quasars they are ‘seeing’ a portion of the universe as it was just after its creation. Whether they will find anything beyond that 3.78 redshift remains an open question. At even higher redshifts quasar light may become too dim to be seen from earth-based observatories, but possibly sightings will be made using orbiting telescopes. Sooner or later astronomers may confront the ‘big bang’ — that moment when space and time had no meaning and the universe was suffused with an energy than man can only theorize about.

A continuing puzzle

The quasars have undoubtedly evolved into something else since the light and radio waves that we now observe left them. In many respects, our understanding of quasars is as incomplete as that of the astronomers who first puzzled over the strange spectrum of 3C48.

Many theories have been put forward about their nature. Probably the most popular involves the mechanisms of ‘black holes’, but others suggest that quasars are the evolutionary forerunner of galaxies or the product of collisions between millions of stars. Closer to the realms of science fiction is the theory that quasars are ‘white holes’, or the other side of black holes, where all the matter and energy sucked up by black holes re-enters the universe.

Despite the uncertainty about their nature, quasars are the most exciting discovery in modern cosmology. A new generation of earth-bound telescopes — including the Very Large Array in New Mexico and the planned Australia Telescope, which will link radio telescopes across Australia as one — will be targeted on quasars. So will the space telescopes, soon to be launched. Together they may help unravel the puzzles surrounding these objects at the very edge of our universe.

Wayne Ralph, EOS

ANZAC Fellowships

A small number of Fellowships will be offered by the New Zealand Government to Australians for 1983. These awards are intended to give men and women who have achieved distinction or who have shown potential in the professions, primary and secondary industry, education, commerce, public service or the arts, the opportunity of training, studying or furthering their professional experience in New Zealand.

Candidates must be Australian citizens, preferably under the age of 45 years. Fellowships are tenable for periods of between 3 and 12 months.

Further information and application forms may be obtained from the Secretary, Department of Education and Youth Affairs (ANZAC Fellowships), P.O. Box 826, Woden, ACT 2606. Closing date, 6th July.
CSIRO’s Information Technology Research

CSIRO Executive would be seeking financial resources for a major expansion in information technology which would increase both advanced research and project-based development.

Both these aspects of the strengthened approach will be carried out in close association with industry, government and other research bodies so that results can be turned into products as soon as possible.

The CSIRO’s Executive has adopted the major recommendations of an expert group which had carried out a study of the Organization’s information technology activities. These included:

- The establishment of a substantial information technology group within the Institute of Physical Sciences to perform advanced research, develop state-of-the-art expertise and participate in collaborative projects in information technology;
- The development of an organization-wide collaborative program with industry, Telecom and others.

The work will cover: software technology and related hardware; man-machine interface; information management; computer networking; and device and systems hardware technologies.

The Executive has also decided to separate CSIRO’s computer network, CSIRONET from the Division of Computing Research. Divisional research staff not working on CSIRONET will form the core of the new information technology group.

CSIRONET will perform research and development related to the operation of the computer network. This work will be paid for by the network’s users, who include other sections of CSIRO, government departments, universities and industry.

Automatic Weather Stations

Three more automatic weather stations are being shipped to Casey this month and present plans call for them to be set up inland of that station during the Spring traverse later this year.

Purpose of the stations is to provide data for a study of katabatic winds. Katabatics are basically the cold air which is cooled in the high interior of Antarctica rolling down the plateau under influence of gravity towards the coast.

The autostations are to be established almost due south of Casey in the direction of the Soviet station Vostok. They will be located at 68°24’5”, 71°36’5”, and 74°08’5”. Each autostation will measure atmospheric pressure, wind direction, snow surface temperature, and both wind speed and air temperature at three levels above the snow surface. The information they provide, plus that collected at the manned Casey and Vostok stations, will enable the wind regime from the high interior to the coast to be monitored. Vostok is located at 3,488 m above sea level, the three autostations at approximately 3200, 3000 and 2000 m, while Casey is at sea level.

Each autostation will pass its data at approximately three-hourly intervals via polar orbiting satellites. This is the same system used by the autostation that was up inland of Mawson in December 1981.

In addition to these surface observations it is also planned that radiosonde soundings of temperature and wind up to 1,000 m above the snow surface will be made during the Spring traverse. These will enable studies of the vertical structure of the katabatic, which is a relatively shallow phenomenon, to be carried out.

Australian metal vapour lasers

After a 4 year intensive R & D programme, Quentron have started taking orders for pulsed metal vapour lasers. Since November, 3 orders have been booked worth $200,000 — two gold lasers for photoradiation cancer therapy and a copper laser for spectroscopy.

Photoradiation therapy is an extremely promising new technique for the treatment of cancer, and has lately been extensively reported in overseas journals such as Laser Focus and Lasers and Applications.

It involves use of the 628nm line emitted by the gold laser and a drug, Hpd (Haematoporphyrin derivative). The two orders for 3W gold lasers for research into this new method of cancer treatment are from the Queen Elizabeth Hospital in Adelaide, where Dr. Ian Forbes, a pioneer researcher in this field has been successfully using a Quentron Gold laser prototype for 2 years, and from the Ludwig Institute for Cancer Research in Melbourne.

The third laser, a 20W copper laser emitting at 510 and 578 nm was ordered by Dr. David James of Queensland University, a leading Raman spectroscopist who intends to develop new applications based on the unique properties of metal vapour lasers.

Quentron see these orders as being very encouraging. To quote Alexei Stancio, the Managing Director, “We have not even printed a data sheet yet, let alone advertised the product, and already people are ordering. What more could you want?”

Export marketing is planned to commence shortly, as soon as brochures are printed.

Although Quentron have had a viable product for over 12 months now (first high power prototype was built 2 years ago), they have held back release until several new technologies in the laser power supply and laser head were implemented.

They claim their lasers are now more efficient, simpler to operate and more reliable than any other currently being offered anywhere in the world.

“We estimate that our competitors now need at least two years to catch up technologically. Had we started taking orders sooner, our R & D would have been delayed and we would not have the technological lead we have now,” stated Stancio.

When asked what the potential export market was Stancio said, “within 2 — 3 years the export market should be in the order of $10M per year, and growing.”

The R & D project has cost over $300,000 and has been supported by the Australian I.R. & D Board. Professor Jim Piper of the School of Maths and Physics

The Australian Physicist, Vol. 21, May 1984 — Page 101
Sun's magnetic fields to be measured

Three University of Sydney scientists are involved on the frontiers of solar research, planning a new telescope — a Stokes Polarimeter — for imaging and measuring the sun's magnetic fields. The tentative location for the new instrument is Hawaii, and it is expected to be operational by 1988.

The project is led by the High Altitude Observatory, Boulder, Colorado.

The scientists, in the Department of Applied Mathematics, are Professor Peter Wilson, Dr David Rees, senior lecturer, and Dr Chris Durrant, lecturer.

The Institute of Astronomy, Hawaii, is funding a programmer in the Department to develop analysis programs for the Stokes Polarimeter.

Dr Rees, Professor Wilson and Dr Durrant, along with CSIRO scientists, form the only solar group outside the USA working with the consortium from American solar observatories on the plans for the new telescope. The CSIRO group, including Dr Lawrence Cram, a former student in Applied Mathematics at Sydney and until recently Assistant Director of the Sacramento Peak Observatory, USA, are in the Divisions of Applied Physics and Radiophysics.

The collaboration between the Sydney group and those in the USA is the continuation of about ten years' interaction on projects between American solar scientists and those in the University's Department of Applied Mathematics.

The Stokes Polarimeter will provide more refined data to help solve many mysteries about the sun, including, hopefully, answers to why solar flares occur. These phenomena, surges of energy that erupt from the sun's surface close to sunspots, can have a drastic effect on communications on earth, sometimes causing complete blackouts.

By understanding more about solar flares, scientists hope they will be able to predict when they will occur and make adequate provisions. Solar flares and other solar activity also have an important effect on our climate.

The new equipment will give fine detail on the direction and strength of the sun's magnetic field. This is vital because the magnetic field is believed to be a fundamental component in the whole structure and energy balance of the solar atmosphere and the solar cell.

For some time Dr Rees has been involved in the analysis of data from the Coronagraph/Polarimeter of NASA's Solar Maximum Mission Satellite (launched in 1980 to coincide with the peak phase of the sun's eleven-year cycle of activity). The Coronagraph provides information about the sun's corona, that part of the sun seen in total eclipse.

The sun's surface temperature is only about 6,000 K, but the corona's temperature is about a million Kelvin, something scientists cannot yet explain. The corona is asymmetrical, often appearing dimmer and less extended near the solar poles, with symmetry varying from one eclipse to another. Certain configurations, which appear in the corona and are described as 'loops', plumes and holes, are caused by magnetic fields. The coronagraph, essentially a small refracting telescope with a disc that obscures the sun as the moon does in an eclipse, creates an artificial eclipse so the corona can be observed constantly.

Coronographs may be used on the ground, or in space vehicles above the earth's atmosphere, from which they provide much clearer images than is possible on earth. Coronographs recorded solar data on the Skylab and Solar Max Missions.

Professor Wilson has collaborated for many years with solar scientists at Sacramento Peak Observatory, Sunspot, New Mexico where the most powerful ground based solar telescope in the world is installed. The tower telescope, at an altitude of 2,800 metres, extends 40 metres above ground to 67 metres below ground, producing an image of the sun 50cms in diameter.

Professor Wilson says that the Observatory has recently developed a means of obtaining simultaneous images of the sun's magnetic field and velocity fields. He is currently involved in the study of these in high- time resolution in order to understand the magneto hydrodynamics of the solar atmosphere. He is also working on a model for the evolution of sunspots and the large scale magnetic field.

Dr Durrant, who joined the University some months ago, is an expert on solar atmospheric dynamics. He has recently completed a major revision, with Dr R.J. Bray and Dr R.F. Loughhead of CSIRO, of a book on the solar granulation. His arrival in the Department, says Professor Wilson, will significantly boost solar research in Australia.

The three Sydney University scientists will also contribute to the Solar Optical Telescope (SOT) due to be launched on Space Shuttle a few years hence. They expect these projects will yield the answers to many questions that are presently being asked by solar scientists.

Exploration Seismology

The Australian subsidiary of Geophysical Service Inc (GSI), a Texas-based world-wide exploration company, has donated a field research unit worth $100,000 to Physics and Geosciences at WAIT for use by the Exploration Seismology Centre.

The equipment, including a 48-channel Texas Instrument seismic receiver, was previously used on the marine seismic survey vessel Banksia.

Housed in a WAIT caravan, the instruments have already been used in tests on a new explosive charge,
which were conducted at the Woodada gas fields as part of continuing research to find new and better ways of detecting seismic energy. Other tests carried out recently at Corrigin, by WAIT post graduate students and staff members, involved reflection methods for measuring the thickness of the earth's crust.

Norm Uren, head of Geology and Geophysics and of the Centre, said that the equipment would enable WAIT to offer the best possible educational training in this developing new technology.

"The seismic method is now the main method of oil exploration, using the very latest in technological equipment and computer processing with approximately $2 billion per annum being spent on this type of exploration, through the free world" he said. "It is a high technology industry vital to Australia in the search for oil and gas and the techniques are so new that some personnel currently involved in the physical operations have had very little opportunity for background training."

One thing leads to another, and last month Phil Langley from Horizon Exploration was on campus to hand over a piece of machinery called a vibroseis unit on six months loan.

It acts like a giant compactor, thumping the surface of the earth to provide sub-surface echoes which indicate underground rock formations. It is used to give the same effect as explosive charges. The seismic reflection is monitored on the GSI equipment.

The field research unit has already been used on a seismic industry four-day training programme at WAIT run by the Exploration Seismology Centre.

As a result, the international well logging company, Schlumberger, has requested a similar four-day programme for its employees.

The Centre, set up on a $40,000 grant from the Director's discretionary reserve, has so far attracted donations from industry of more than $141,000.

New Zealand Institute Of Physics (Inc) Presidents’s Report 1983

We are now an established independent organisation, having completed our first year of active and successful existence as NZIP. The highlight of the year was undoubtedly the national conference in May attended by over 200 physicists including an impressive array of international speakers. The success of this conference was very encouraging for the organisers of the next in the series, to be held in 1985 in Dunedin. Other significant developments have occurred. The rather less stringent Constitution that we adopted has seen a growing interest in membership of NZIP amongst groups not formerly strongly represented in IOPNZ.

This is what was intended and applies to physics teachers in particular. We now have 40 Fellows, 105 Members and 14 Student Members. Included amongst these are 23 teachers. We welcome all new members and look forward to their active contribution to NZIP.

We are now recognised by the Australian Institute of Physics and the American Institute of Physics as an independent group, and have joined the Asian Physical Society. Financial assistance for two NZIP representatives to attend the first Asia-Pacific Physics Conference was provided this year falling any government assistance being available. This is not seen as something we should do regularly. We have also been offered journals published by IOP, AIP, and American I.P. at reduced rates as advertised in the August "N.Z. Physicist", but the very poor response to these offers will preclude their being acted on at present.

The 1983 Laser Summer School was granted a $750 subsidy for student support and a $600 subsidy for student support for the Physics of Condensed Matter Meeting next February has been approved. This is a joint AIP/NZIP sponsored meeting. We increased support for students in all grants to such schools and to our conference this year and feel this to be worthwhile. A donation of $200 to the Beatrice Tinsley Medal fund was also approved. Professor Tinsley who died recently was a New Zealander with a distinguished career in astrophysics. The medal will be a prestige award organised by the American Astronomical Society.

The Australian Physicist, Vol. 21, May 1984 — Page 103
In conclusion, we must acknowledge the very generous co-operation received from the I.O.P. London throughout our move to independence. This was of great assistance to us, and we look forward to continuing close and amicable contact with them. I wish to acknowledge the extensive efforts of Chris Tindale our Secretary/Treasurer, a combined position which should perhaps be separated in future. On behalf of the present Council may I wish the incoming Council, to be centred in Dunedin, a very successful term. R.E. White President, NZIP (Inc.)

Japan science exchange programme

Funding has been approved for exchange visits between Australia and Japan in the 1984/85 financial year in the field of basic research in natural sciences. They will take the form of three or four week visits by senior scientists who will give lectures and exchange ideas and information.

Interested scientists may obtain information from the Executive Secretary, The Australian Academy of Science, G.P.O. Box 783, Canberra ACT 2601.

Deadline for applications 15th June 1984.

Labelling Rye

In a world where many people are undernourished, the introduction of a major new food plant is a rare but important event.

Triticale is such a plant. Strictly speaking, it’s not absolutely new, but the modern version is rather different from the original, produced almost a hundred years ago when a Scottish botanist crossed wheat (Triticum) and rye (Secale).

The breeder’s aim was to combine the high productivity of wheat with the greater disease resistance and drought tolerance of rye, which performs well in cool regions with sandy, acid soils.

Disappointingly, the hybrids proved to be sterile — although diploid wheats have the same number of chromosomes as rye, seven — the cross was performed between rye and a tetraploid wheat, so the resulting plant were sterile triploids.

Today’s triticales are not even hybrids, in the true sense, but are basically hexaploids which three to five wheat chromosomes have been deleted and replaced by their rye counterparts. The first triticale producers were in North America in the 1950s, but plant breeders since then have still not been happy with the product.

Its worst features have been a tendency to blow over in storms, low grain yield, and slow ripening — hardly a cereal to alleviate the plight of the world’s undernourished people.

Persistence has been rewarded. Many of triticale’s deficiencies have been overcome by back-crossing it with wheat — the progeny are more resistant to lodging (blowing over) and produce an improved grain in quantities rivalling high-yielding wheats. Some triticale varieties also show a useful degree of salt tolerance.

This new cereal is already being grown in countries where agriculture is highly mechanized, including Australia. The grain is used as stock feed, and also produces a flour similar in texture and flavour to wholewheat flour. It has also been considered as a feedstock for fuel production by alcoholic fermentation.

Agricultural scientists are pleased with triticale’s performance in Third World countries such as Mexico, where animal-drawn ploughs and hand-harvesting are still employed. They admit it will never replace wheat, but it may help to relieve famine in areas where large populations depend on marginal land for cereal production.

One of the obstacles to systematic development of triticale has been the difficulty in determining which rye chromosomes have been incorporated in place of the deleted wheat chromosomes — they are so similar in appearance that they cannot be told apart by shape alone.

A recent Australian development has solved this problem. A CSIRO research group has found a method of attaching radioactive ‘labels’ to the rye chromosomes, so they show up with black speckles on their ends when triticale cells are placed on a microscope slide coated with a photographic emulsion sensitive to radioactivity. The technique is based upon the fact that the DNA at the ends of wheat and rye chromosomes differs— specifically, the highly-repeated ‘silent’ DNA whose role in gene expression is still a mystery.

The CSIRO technique involves isolating and cloning these sequences, making the clones mildly radioactive, and then injecting them into triticale cells.

The clones and the chromosomal DNA is temporarily induced to ‘unzip’, and then allowed to zip itself up again according to the base-pairing rules of the genetic code.

Some of the cloned DNA seeks out its matching sequences on the rye chromosomes, and occupies the sites before the matching chromosomal DNA can find its way back ‘home’.

Presto, a radioactive label is attached to the rye chromosomes. Wheat chromosomes remain unlabelled, because they lack sequences to match the cloned ‘labels’.

The result is that the triticale has acquired rye chromosomes, with their rich complement of genes, can be confirmed at the cellular stage, without the need to grow the plant to maturity. Substantial savings in time and growing space should result.

— Biology in Action

Hospital physics

I feel I must bring to the attention of the membership the closure of the Physics Department at Guy’s Hospital Medical School on 30 September 1983.

A reduction in the academic staff of the department had been effected as early as 1976 when no candidate was selected for the vacant chair in medical physics. Later, the Reader acting as Head of Department was appointed to fill the vacancy. In 1980 the Biology Department in the Medical School was closed, and with the disbandment of the 1st MB examination and now the closure of the Physics Department, activity in the basic sciences as applied to medicine will have ceased.

The closure comes with the retirement of Professor S J Wyard, but the four lecturers have been made redundant, and as a reason for closure it has been stated by the Dean that the redundancy is academic and is not based on financial grounds.

Dr N G Trott reported in the June issue of Physics Bulletin (p223) that the old established departments of medical physics in medical schools, particularly in London, are facing severe problems. Dr David Newman, one of the redundant physics lecturers, has received and published the views of seven scientists from around the world on the closure (Guy’s Hospital Gazette 27 May 1983 p222-3). That from Professor J Rothblat, Emeritus Professor of the University of London, reads: ‘I came
as a shock to me to hear about the plan to close the Physics Department at Guy's Hospital Medical School. This seems to me a most retrograde step. Together with similar threats hanging over the physics departments in other medical schools of London University, it would be a terrible loss to science and medicine. I am sure that we shall for ever regret this action.

In conclusion, I must express my concern at the closure. Is it time for Council of The Institute of Physics to review the diminishing role of academic physics in medical education and medical research?

R.E. George
Guy's Hospital, London
Physics Bulletin

Satellite information tracking centre in Scotland

A centre to interpret, collate and market information transmitted from remote sensing satellites has been established at Livingston New Town, near Edinburgh. A European first, it is called the Environmental Remote Sensing Application Centre (ERSAC) and will market information independently worldwide.

The sensing satellites - nicknamed "flying eyeballs" - carry instruments which scan the earth's surface collecting data on a variety of subjects. The "eyeball" can be programmed to pinpoint mineral deposits, detect oil slicks, monitor crop growth, track fish shoals or icebergs and redraw maps.

Opening the centre on 11 November, Mr Kenneth Baker, Britain's Minister for Information Technology said: "In 1980 my department and others set up the National Remote Sensing Centre (NRSC) at Farnborough where data from the American Landsat earth observation satellite is collected and processed. The Centre will work closely with the NRSC, offering its service internationally to survey companies, the oil industry, government planning departments and other agencies requiring special image processing and interpretation facilities.

The Gems image processing system at ERSAC will be operated through a powerful prime computer which will handle output from the growing number of remote sensing satellites currently in orbit, including the NASA vehicles.

Pawsey Memorial Lecture 1984

Melbourne University, Thursday, July 26th.
Photon Counting Imaging and Australian Astronomy with STARLAB
Dr. Alex W. Rodgers, Professional Fellow, Australian National University with the Mt Stromlo/Siding Spring Observatories.

ABSTRACT
The principles of operation and technology involved in the photon counting imaging system to be used in the Australian instrument package for the STARLAB space telescope project are described. The role of Australian development and technology is highlighted and the significance of the new generation of space optical telescopes in the history of Astronomy is discussed with relevance to the maintenance of the Australian role in this branch of Physics.

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Conferences and Meetings

1984
May 23-25  Deformation, Failure and Strengthening of Polymers. Monash. Dr. G.B. Guise, P.O. Box 224, Belmont, Vic. 3216.
May 28-June 22 Radioisotope Course for Non-Graduates No. 33. Lucas Heights. Principal, Aust. School of Nuclear Technology, P.M.B. Sutherland, NSW 2232.
July 9-11 Chemistry and Physics of Elastomers, Sydney, Course and Seminar. R.P. Burrard, NSW School of Chem. Eng. and Industrial Chem. P.O. Box 1, Kensington 2033.
July 23-Aug. 17 Radioisotope Course for Graduates No. 30, Lucas Heights. The Principal, Australian School of Nuclear Technology, Private Mail Bag, Sutherland, NSW.
Aug. 15-17 Progress in Optical Physics, Melbourne. Dr. J.J. Wilson, CSIRO Divn. of Chemical Physics, P.O. Box 250, Clayton, Vic. 3168.
Aug. 20-24 Engineering and Physics in the Life Sciences, Adelaide. EPLS ’84 P.O. Box 24, Rundle St., Adelaide, SA 5000.
Aug. 24-30 5th International Congress on Mathematical Education, Adelaide. ICME 5, G.P.O. Box 1729, Adelaide, S.A. 5001.
Aug. 27-31 3rd Int. Conf. on Solid Films and Surfaces, Sydney. Prof. D. Haneman, School of Physics, UNSW, P.O. Box 1, Kensington, NSW 2033.
Aug. 27-31 6th National AIP Congress, Brisbane. Dr. B.W. Thomas, Department of Physics, Q.I.T., G.P.O. Box 2434, Brisbane, 4001.
Aug. 27-31 ANZ Soc. for Mass Spectrometry Inc., 9th Conference, ANU. Dr. M.Lacey, 9th ANZMS, Divn. of Entomology CSIRO, G.P.O. Box 1700, Canberra.
Nov. 26-28 9th Biennial Conf. of the Australian Clay Mineral Society, Canberra. ACMS-9 Conference, G.P.O. Box 1929, Canberra, ACT 2601.

1985
July 7-12 World Congress, Federation for Ultrasound in Medicine, Sydney. Dr. G. Kossor, Ultrasonics Institute, 5 Hickson Rd, Milsons Point, NSW, 2061.
July 9-11 IFAC Symposium of Automation for Mineral Resource and Development, Brisbane. Chief Executive Officer, AIMM, P.O Box 310, Carlton South, Vic, 3053.

National technology strategy

A discussion draft of a National Technology Strategy which has been prepared as a result of last year’s National Technology Conference (see the AIP submission, Aust. Phys. 20, 242 (November)) is now available for comment. Copies of the document can be obtained from The Department of Science and Technology, P.O. Box 65, Belconnen ACT 2616.

The Institute will be providing formal comment, and anyone who wishes to make specific contributions should write to The President, Professor G.V.H. Wilson, Royal Military College, Duntroon ACT 2601, before the end of June.

Statements by the Prime Minister and the Minister for Science and Technology indicate that they regard a full discussion of this document as an important input into Australia’s development and that it is part of the process of Government through cooperation and consensus. It is therefore essential that all who have an interest in science and technology should take the document seriously.

Some excerpts will be published in the next issue.

The Australian Physicist, Vol. 21, May 1984 — Page 106