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The Australian Physicist

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President’s Column

Several years ago I attended a meeting which was organised by the Academy of Science to discuss problems of professional institutes and societies. Although those attending came from a very wide variety of societies it was interesting to note the similarity of many of their organisational features and problems. One person gave a talk in which he compared aspects of a number of professional bodies; his conclusion was that bodies with memberships of less than a few hundred were easy to operate using honorary office holders while bodies with over about 5000 members could afford to hire their own administrative staff. I noted that, on a logarithmic scale the AIP, with about 2000 members, falls near the centre of the difficult region.

Much of the success of the Institute is due to the hard work and dedication of its Honorary Secretary, Treasurer and Registrar. John McFarlane has indicated that he intends to step down as Honorary Secretary after the next AGM (in March 1985). John has made a wonderful and highly appreciated contribution to the Institute. I would be most grateful for any ideas, or preferably offers, on his replacement. Also, to make the task of Secretary easier, the Executive Committee is keen to appoint, as soon as possible, an Assistant Secretary; the main task would be to maintain minutes and agenda papers for the Executive. Please let me know if you can help with this.

Finally the Executive has considered the suggestion that the Institute should appoint a part-time paid Executive Assistant to assist with more demanding initiatives such as our response to the Draft National Technology Strategy and studies on the employment of physicists. Such an appointment might suit a retired member and I would be most grateful for any suggestions on this.

[Signature]

Editorial

Last month in this column I suggested that physicists had an important role to play in clarifying the concepts used in public discussions on technology. Aside from the benefits of helping establish a well defined, if not well ordered universe, it is apparent that policies related to funding of applied research, development and production may be related as much to the funding body’s assessment of the height of the high-tech, as to its assessment of financial viability. These funding bodies include a growing number of venture capital companies — with and without M.I.C. licences — as well as government agencies and traditional financial institutions.

Who will evaluate the technology of these ventures? How will they be evaluated? Who is to say that the criteria and evaluation methods are sound and satisfactory? It is almost conventional wisdom that for every thousand “good ideas” only one will be a “winner”, with only a handful paying their way and the rest sustaining varying degrees of loss to the venturers. One might well wonder, with such statistics, whether the systems of evaluation used to choose projects for funding are the best of all possible worlds.

It is likely that the present system of technological evaluation could be improved upon to everyone’s benefit. Often there is a feeling that the “expert” chosen to evaluate the technological aspects of the project did not use explicit and systematic evaluation procedures, but relied principally on personal experience and innate wisdom.

It comes as a surprise to many that evaluation methodology is a well established discipline. Procedures can be developed to both ensure that all conceivable aspects of a proposal are covered and to assign a rational weighting factor to each aspect. This doesn’t mean that the expert can be replaced by a computer program, but it does allow for the creation of a rational system that can be discussed, defended and improved upon to the benefit of all parties concerned.

Physicists will be called upon, with increasing frequency, to evaluate proposals in new technology. By the very nature of the projects, the evaluator is not likely to be an expert on all aspects of the project — otherwise they probably would have thought of it themselves. The key, therefore, to providing the best evaluation possible will be to develop rational and generally agreed upon procedures. This is a task to which physicists will have to address their attention, and without delay.

John Barker
The Australian Physicist, Vol. 21, August 1984 — Page 155
Dear Sir,

This letter is to advise you that I am no longer the Editor of the "New Zealand Physicist". All correspondence, Editorial copy, and our Editor's copy of the "New Zealand Physicist" should be now sent to:
The Editor, NZ Physicist,
Dr John Bahr, Physics Department,
University of Otago,
Dunedin,
NEW ZEALAND.

Thank you for your co-operation during the time I have been Editor. The Australian Physicist enjoys a high reputation in New Zealand — my congratulations on the quality of the articles and publication.

Gary E.J. Bold
ex-Editor, NZ Physicist

* * *

Sir,

The article by Professor L. Finkelstein entitled "Two professions: Physics and Engineering" reprinted in the May issue of The Australian Physicist deserves close attention and discussion.

The author addressed some of the consequences of the strengthened role of the engineering profession in setting standards for engineering courses in the U.K.

The preeminence of the Institution of Engineers (Australia) in this role is well known to professional engineers and educators in Australia. The Institution sets guidelines to the content and implementation of engineering courses.

Professional recognition of an engineering course, following its detailed examination by the IEE (Aust), confers eligibility for Institution membership upon graduates of that course. In turn, eligibility for membership of the IEE (Aust) permits entry to engineering positions in the Commonwealth Public Service.

In Australia the minimum requirements for professional recognition of a Bachelor of Engineering course are that it be of four years' duration and that it should include specified management, design, applications and communications components in addition to basic engineering science material.

In designing a Communications Engineering Course and in redesigning Applied Physics and Electronics Courses at the Canberra College of Advanced Education, we have had to consider some of the matters raised by Professor Finkelstein relating to the training and employment of applied physicists and engineers.

In particular we believe that an applied physics degree course should, like an engineering course, include design, applications and management components in addition to basic science material.

Furthermore, with the inclusion of this additional material, it becomes increasingly difficult to regard a three year degree as a full professional qualification in applied physics.

While it is generally recognised that a career in physics generally requires more preparation than that provided by a three year bachelors degree course, it appears that Colleges of Advanced Education are expected to train an applied physicist in three years.

At the other extreme a PhD will take seven or eight years to complete in a university physics department. It should be no surprise therefore to find that Australian students prefer to take four year engineering courses designed to meet professional needs rather than three year physics courses with uncertain objectives or seven year doctorates.

Nevertheless, if the sun is to rise on Australian industry, applied physicists will be needed to teach, research, develop, manage and transfer physics based technology.

I believe that properly designed four year courses will help to attract good students to careers as physics trained technologists. The provision of four year applied physics courses and postgraduate goal-oriented research project training in the Colleges of Advanced Education and Institutes of Technology will surely assist in the development of technology and in its application to Australian industry as called for in the National Technology Strategy Draft.

Is the Australian Institute of Physics prepared to meet this challenge by following the example set by the Institute of Engineers?

P.J. Edwards FAIP FIEEE MIE (Aust),
Electronics Engineering and Applied Physics,
School of Applied Science,
Canberra College of Advanced Education

* * *

Dear Sir,

As a longstanding member of the Australian Institute of Physics I read with great interest R.A. Joseph's article, "Nuclear Power and the proliferation of Nuclear Weapons" in the May 1984 issue of The Australian Physicist. However, I would like to express my dismay at the extraordinarily large number of typographical errors in the text, and my amazement that three of what appeared to be major references for the article — SANA (1983), SANA (UK) and SANA (1984) — did not appear in the list of References. It would therefore be very difficult for a reader interested in the subject to pursue these references further.

Much of the material used in the article would seem to have been drawn from the SANA submission to the Australian Government’s Enquiry conducted by ASTEC into "Issues Relating to Australia’s Role in the Nuclear Fuel Cycle", January 1984. I assume that this was not acknowledged because the submission could not legally be made public until the report of the Committee had been tabled in Parliament. As this has now been done, copies of the submission are available from SANA, PO Box 370, Lane Cove NSW 2066.

These remarks should not be construed as a criticism of the article per se. It is encouraging to see The Australian Physicist publishing informative articles on matters of such vital interest to all scientists.

Dr R.F. Hayne,
14 Bogan Place,
WAHIROONGA N.S.W. 2076

* * *

Dear Sir,

Whilst Dr. Campbell's figures on publications and grants (The Australian Physicist Vol. 21 No. 3, April, 1984) make interesting reading, we must inject a note of caution about taking the conclusions too seriously. In particular, to take the level of funding as an indicator of research quality is to make a dangerous and fundamental error, which unfortunately is becoming more prevalent.

As pointed out by Loudon and Tilley in a recent article in Physics Bulletin (Vol. 35, No. 1, January 1984),
p. 6), "the need to seek research grants and the sizes of grant awarded are almost entirely determined by the nature of the research and not its quality". They comment that emphasis on the amount of funding as an index of performance would imply that an industry relying on the greatest governmental subsidy would be seen as being the most excellent.

A more useful indicator, in these times of financial constraints, of the effectiveness of research might be the "efficiency", measured as the number of publications and/or citations per grant dollar received. We will not tabulate detailed figures, but it is clear that this completely changes the "rankings" of University Departments.

To sum up, there is no reason why someone who can do high quality research on a small budget, usually as a result of careful forethought, should automatically be regarded as inferior to someone who cannot perform research without great expenditure. We urge that the notion of regarding input money as a measure of output be abandoned.

H.P.W. Gottlieb,
D.T. Gebb,
School of Science, Griffith University

Dear Sir,

I refer to the paper "Comparative Evaluation of the Research Performance of the Australian University Physics Departments" which appeared in the April 1984 issue of The Australian Physicist (Vol. 21, No. 3, p. 58).

The results of this survey have recently received some publicity in Australian daily newspapers (Sydney Morning Herald, 18th June, p. 14 and Canberra Times, 17th June, p. 3) and the implied deficiencies in research productivity of certain university physics departments, including that of which I am a member, have been highlighted. This publicity has, in the case of the A.N.U. Physics Department, caused considerable and unjustified damage to the reputation of the Department in the eyes of our colleagues, present and potential students, and the general public.

The evaluation criteria used by the authors of the survey were publication productivity (the number of publications per staff member), the citation rate (per staff member and per paper) and the number and value of research grants from external funding bodies (again per staff member). Prima facie, these appear to be reasonable criteria, however, on closer examination, they are seen to be crude and superficial as they fail properly to take into account the qualitative aspects such as the length and substance of published work, differences in references, standards of journals, the marked differences in the equipment costs in different fields of research, the number of people required to carry out certain research projects, whether the work was experimental or theoretical and so on.

The authors seek to justify the rate of citations as a valid measure of the relative significance of research publications. This may be so in some cases. However, it is also well-known that one of the best methods of obtaining a large number of citations is to measure or "discover" something important (e.g. free quarks) and to get it wrong! Such a paper is then inevitably cited by the many who then set out to show that it was wrong.

In the case of the A.N.U. Physics Department, significant parts of the data used in the survey were misleading or just plain wrong. The number of staff used was 11. This was the maximum for the survey period and included one who had previously been a member of the Department but who, during the time of the survey, was a full-time member of the administrative staff of the University and who carried out no research or teaching in the Department. The average number of staff in the Department during the survey period was 9. The total value of ARGCC grants to the Department for 1977/78 to 1982/83 is given as $92,147 with an average number of grants per staff member of 1.0. In fact the total amount was $299,765 and the average number of grants per staff member was 3.0.

With these corrections the ranking of the A.N.U. Physics Department improves markedly but this is of little significance since one can only wonder about the accuracy of the date used for other Departments. What is significant is that superficial surveys of this kind, based on dubious criteria and apparently unverified data, which are then widely promulgated, do no good service to the cause of physics research in Australia and in some cases cause gratuitous harm.

Dr A.M. Baxter,
Physics Department,
Faculty of Science, A.N.U.

Recent Higher Degrees in Physics

The Collisional Dissociation of \( \text{H}_2 \)

Studies by Translational Spectroscopy.

Seng Chow Goh, Physics Department, University of Western Australia, Awarded September 1983.

The thesis describes the experimental techniques and data analysis methods used in translational spectroscopy, in which the centre-of-mass dissociation spectrum is derived from the laboratory-frame energy spectrum by a new method.

The results demonstrate that the dissociation spectrum is sensitive to the initial states' distribution of the primary ions, prior to their collisional excitation and dissociation. This distribution may be altered by changing the ion source design and operating conditions, and dissociation spectra are presented for a variety of source conditions.

It has been found that dissociation of the stable \( \text{H}_2^+ \) ion proceeds by vibrational excitation within the ground electronic state 'A', and by electronic excitations to the unbound 'E' and 'A' states, with the production of both \( \text{H}^+ \) and \( \text{H}_2^+ \) fragments.

The energy limits of the spectra of the \( \text{H}_2^+ \) fragments in particular were recognized as providing a definite measure of the 'A', ground-state binding of \( \text{H}_2^+ \). From the spectra of monoeenergetic primary ions with energies in the range of 0.5 to 2.5 keV, the relative cross sections for the different excitation processes are determined, and a binding energy of \( -1.33 \pm 0.01 \) hartree is obtained, in good agreement with theoretical predictions.


Present address: Telecom Research Laboratories, Clayton, Victoria.

The Australian Physicist, Vol. 21, August 1984 — Page 157
Proposed Upgrading of the Accelerator Facilities at the Australian National University

T.R. Ophe
Department of Nuclear Physics, R.S. Phys.S., A.N.U.

Introduction
The intention of the present paper is to outline a proposal to upgrade the 14UD accelerator at the Department of Nuclear Physics, ANU. In brief, capital funding of $6.7M is being sought to add a superconducting booster to the accelerator. The addition will provide the equivalent of a 28 MV (million-volt) terminal as compared with the present 14MV.

The Department carries on research using heavy ion beams. The work encompasses facets of all the interactions possible between projectile and target nuclei. While reactions occur only for very close encounters (10^{-4} cm) due to the short range of nuclear forces, Coulomb effects beyond this range and electron exchange processes at very large separation distances are also studied. The main thrust of the reaction work is directed toward the dynamic and structural behaviour of nuclear matter under severe, rotational stress and the properties of "exotic" nuclei which have anomalous proton/neutron ratios. All of the work relies on features unique to heavy ion projectiles. In the reaction work for example, the very large angular momenta produced by the coalescence of the projectile and target nuclei and the means to initiate complex, multi-nucleon exchanges between the two nuclei are essential.

For nearly 10 years, the ANU has had a unique facility and it has been fully exploited to achieve worldwide recognition both for the research and for the technical expertise required to achieve optimum performance.

Our wide-ranging experimental program is becoming severely restricted by the terminal voltage limit. No less importantly, new and much larger installations in the US, UK, Japan and Argentina are coming into operation with terminal voltages between 15 and 25 MV. In a highly competitive field, the "cutting edge" of research is at the limits of technology. New and exciting nuclear phenomena continue to be discovered as beam energies and projectile masses are extended by technical innovation. In a few years, the research areas available to the Department will become limited and of rapidly decreasing significance. Upgrading of the facilities is essential if research at the forefront is to be continued.

Replacement of the 14UD accelerator would cost 30-40 million dollars. Fortunately, a remarkably cost-effective alternative is available. It is cost-effective in that the equivalent of a 28 million volt terminal is achieved at a fraction of the replacement cost and also because it provides a way of fully utilising the considerable past investment in nuclear physics at the ANU.

The alternative, i.e., the addition of a booster, was made possible by the development over the last decade of several high frequency superconducting resonant structures. The resonators are made either of niobium- 

Conclusion
Accelerator Manager Dr. David Weiser, in the Department of Nuclear Physics, is responsible for the withdrawal of the superconducting resonator cavity device from the cryostat — a vacuum chamber to maintain low temperature (that of liquid helium) for superconduction.

Technical foundation of the proposal
In order to explain how resonators can be exploited to boost the energy of beams from an electrostatic accelerator, it is useful to review the way in which a tandem accelerator operates. A continuous beam of negative ions (i.e., atoms with an additional electron attached) is produced at the ion source (Figure 1) and injected, with an energy of 150 keV, into the accelerator. In acceleration to the central, positively-charged terminal, the ions gain an energy \( V_T \) MeV, where \( V_T \) is the terminal voltage in MeV. At the terminal, the ions pass through a thin carbon foil which strips off most of the electrons. The resulting positive ions are accelerated out of the accelerator, gaining an additional energy \( qV_T \) MeV (\( q \) is the charge state of the ion). For light ions such as lithium, the fully-stripped \( 3^+ \) component is predominant; for ions such as carbon and oxygen, the emerging beam is made up of three main components (4\(^+\), 5\(^+\), 6\(^+\), and 6\(^+\), 7\(^+\), 8\(^+\) respectively). An analyzing magnet is normally used to select the charge state component which has the energy and intensity consistent with experimental requirements. Where it is desirable to have more complete stripping than is possible at the terminal foil, the high energy output beam is passed through a second stripper foil after the analyzing magnet. In this way, the predominant charge state of a nickel beam can be increased from 10\(^+\) to 22\(^+\).

---
* Presents only required for electron exchange measurements. In what follows, the significance of being able to increase the predominant charge will become evident.
If beam from the 14UD is passed through a resonator and the excitation power varied, the results shown schematically in Figure 2 can be observed using energy and time of arrival detectors downstream of the resonator. Some 30% of the total incident beam is bunched into narrow peaks with a width of less than 50 picoseconds (after unfolding a comparable instrumental width). This bunching arises from that portion of the beam passing through the resonator as the voltage changes in an approximately linear way from positive to negative. The early ions are slowed by the positive voltage and the lagging ones accelerated by the negative voltage so that, for some value of the effective field in the resonator determined by the distance between the resonator and the target, all particles arrive at the target almost simultaneously. The energy detector verifies that such energy changes have occurred to provide the time focus. Whereas all of the incident \(^{13}\)C ions had a energy of 62.5 MeV, the emerging ions are spread in energy between 61.4 and 63.6 MeV. Obviously, the extremes occur when the ions enter at the maximum voltage excursions of the resonator. The results of an actual measurement made at ANU are shown in Figure 3. A beam of \(^{13}\)C\(^{+}\) ions, with an energy of 62.5 MeV, was passed through a commercially supplied resonator operating with an effective field over the cavity length of about 1 MV/metre. All four effects of the resonator viz, bunching, debunching, acceleration and deceleration, are evident. A booster exploits all four of them.

In its simplest form, a booster is a linear assembly of resonators, phased so that the beam enters each one at the correct time for maximum acceleration. To maintain a high beam quality, i.e. minimum energy spread, the beam entering each resonator must be pulsed or tightly bunched so that all the ions are accelerated by the same amount. Thus the beam required for injection into a booster consists of ions, highly-striped for maximum acceleration, and bunched into pulses less than 100 picoseconds wide to minimize energy spread.

The high terminal voltage of the 14UD makes the accelerator an ideal source of highly stripped ions. It has already been shown how a single resonator following the 14UD can be used to produce sufficiently narrow pulses. However, pre-bunching of the 14UD beam is required to obtain maximum beam intensity within each pulse and to remove all stray beam (‘dark current’) between pulses. Pre-bunched pulse widths of about 1 nanosecond can then be compressed with a resonator.

Introduction of booster technology

To introduce the relevant technology and as a means of expanding the experimental capability of the 14UD, beam pulsing appropriate for a booster has already been implemented. First, the beam is bunched by applying a sinusoidal waveform at a frequency of 9,375 MHz to gridded electrodes situated near the entrance to the accelerator (Figure 1). Modulation of the injected beam energy of 150 keV by about 1 keV provides a time focus with a width of less than 1 nanosecond at the stripper in the terminal. Beam leaving the accelerator passes through deflecting plates, phased to give no net deflection when the pulses pass through them. The remaining 60% of the beam intensity, which is distributed between the pulses, is deflected into the walls of the beam pipe. Thus the analyzed beam consists of discrete pulses, with a width of 1 nanosecond or less, at intervals of 104 nanoseconds and with essentially zero dark current in between the pulses.

Final compression of the pulse width to less than 50 picoseconds has been achieved using a commercially supplied lead-plated split-loop resonator as a superbuncher. A room temperature resonant device, located between the analyzing magnet and the superbuncher, is sufficiently sensitive to detect the beam pulses passing through it. Output signals from the device provide the means to phase-lock the low frequency
buncher to the super-buncher in order to correct for small variations of the transit time through the accelerator.

Following successful completion of the pulsing project, construction of a mini-booster made up of 4 resonators has begun. A different configuration, a quarter-wave resonator, is involved. The main purpose of this second project is to evaluate the properties of this potentially superior structure and our ability to manufacture them. Numerical-machining, electron beam welding and polishing and plating procedures, are required to produce the required surface finish.

The proposal

Funding is being sought for a booster to consist of 40 resonators to be housed in 12 cryostats; the number of resonators being a compromise between cost and the ability to enter into new research areas. Conditional on the outcome of our evaluation, it is planned to use quarter-wave resonators. With an effective field of 3 MV/metre throughout, acceleration per charge state will be 20 MeV. It would become possible to accelerate 0 to 253 MeV (maximum of 120 MeV at present) and 56Ni to 632 MeV (250). The beam energies produced would increase the mass of projectile nuclei available for comprehensive reaction studies to beyond 100 from the present limit of about 32. (A booster can also decelerate to provide low velocity, highly-stripped ions. These are of potential interest to atomic physicists. Groups in Australia are presently being canvassed to see if an experimental program can be established.)

The capital cost of $6.7M, which can be staged over three years, stems mainly from four comparable components—helium refrigeration (280W), resonators, cryostats and magnets for bending and focussing the beam. The loop configuration chosen (Figure 4) directs the output beam back into the existing target area. This is done to reduce overall cost and technical staffing requirements. The project will take 3-4 years to complete, providing the Department with a facility adequate to maintain research at the forefront of heavy ion physics for at least another ten years.

In conclusion, the proposal represents the culmination of a long term plan in which much of the relevant new technology has been gradually introduced and assimilated. In view of the importance of maintaining vigorous basic research in Australia, it is essential that the project be funded to begin in 1986.

Fibre optics development

A $5.4m research and development contract has been awarded to Australian Optical Fibre (Research) Pty Ltd, a Wormald subsidiary.

The contract, under the "public interest" provisions of the Industrial Research and Development Incentives Act, will enable Wormald to undertake research and commercial development of fibre optic sensors and sensor systems.

Mr Barry Jones, Minister for Science and Technology, said the contract would make Australia a leading international force in the new advanced technology of fibre optic applications and create new health and employment opportunities.

It is expected that by the end of the 1980s, fibre optic sensors will begin to dominate the world sensor market, progressively superseding current mechanical, electrical and electro-mechanical sensors in many fields.

They can be used as sensitive, low-cost sensing elements in temperature controllers, pressure sensors, vibration detectors, gyroscopes, compasses and many other applications. With few moving parts, such devices will be simple to make, more reliable and far more sensitive.

Mr Jones said these developments originated from outstanding work undertaken in the Research School of Physical Sciences at the Australian National University. A research group in the School's Department of Applied Mathematics, led by Professor Alan Snyder, made the important breakthrough in optical fibre design that opens the way for the technological advance in fibre optic sensors.

Wormald is one of Australia's leading export-oriented companies. Australian-owned, entrepreneurial, and with subsidiaries throughout the world, they are world leaders in the provision of security systems for home, office, factory and defence applications.

The company will establish a fibre optic sensor research facility in Canberra taking advantage of the national capital's high-technology environment and enabling close interaction between Wormald's engineers and scientists and researchers at the Australian National University.

Mr Jones congratulated Wormald on being successful in attracting back to Australia Dr Scott Rashleigh to head the project. Dr Rashleigh, an Australian, is held by many to be the world's leading researcher in the development of optical fibre sensors. He is working at the Naval Research Laboratories in Washington and has agreed to return as Research Director for the project.

Given the capabilities of Wormald and the relationship with the Australian National University, it is expected other Australians working in this field overseas will also be attracted back to Australia.
More Active Nuclear Role Proposed

The best way for Australia to contribute to non-proliferation of nuclear weapons is by being a stable supplier of uranium and playing a more active role in the nuclear fuel cycle, according to a report by the Australian Science and Technology Council.

ASTEC’s report, carried out at the Prime Minister’s request, was tabled in Parliament on May 31.

It is the result of a 6-month inquiry by a committee led by ASTEC chairman Prof Ralph Slater, head of the research school of biological sciences at the Australian National University.

The inquiry aimed to investigate:
- the adequacy of Australia’s nuclear safeguards arrangements and the scope for strengthening its bilateral and multi-lateral agreements.
- the opportunities for Australia to advance the cause of non-proliferation through involvement in the nuclear fuel cycle.
- the adequacy of existing technology for handling and disposing of nuclear waste and the ways Australia can help develop safer disposal methods.

The inquiry received about 50 submissions on these issues from individuals and organisations.

The report strongly supports Prime Minister Bob Hawke’s pro-uranium stance by recommending that “exports of Australian uranium should not be limited as a matter of principle but should be permitted subject to stringent conditions of supply designed to strengthen the non-proliferation regime”.

It also recommends that Australia’s participation in the nuclear fuel cycle should be allowed to expand to include enrichment and reprocessing as well as mining and milling “where such participation promotes and strengthens the non-proliferation regime”.

It says sensitive facilities such as enrichment and reprocessing plants should be established under joint international ownership and supervision, and raises the possibility of Australia and Japan cooperating to provide these services for other countries in the Pacific region.

The report rejects the idea of Australian uranium being diverted for civil use being diversified for weapons.

“Although there is public concern that by being a supplier of uranium Australia is likely to contribute to the proliferation of nuclear weapons, we conclude that this is not the case and that the risks of proliferation will be reduced.”

“Australian uranium is supplied under very stringent safeguards against diversion to use in weapons. Furthermore, there is good evidence that the imposition of these safeguards has not deterred prospective purchasers of Australian uranium.”

“Their acceptance may encourage other suppliers of nuclear equipment as well as uranium, to insist on comparable conditions.”

Some submissions to the inquiry argued that Australia should cease supplying uranium to states with nuclear weapons because Australian uranium, even if used for peaceful purposes, liberates other material for weapons programs.

The report rejects this idea on the basis that those states can supply their weapons programs from indigenous reserves and need not rely on imports.

“We believe, therefore, that while supply of Australian uranium could in theory release other material for weapons use, in practice this does not occur,” it says. “Indeed we conclude the denial of supply to nuclear weapons states would not affect in any way their weapons programs. To do so would be an empty gesture and would certainly not advance the cause of disarmament.”

The report says the Non-Proliferation Treaty (NPT) of 1968 has been weakened by the continued build-up of nuclear arsenals by the nuclear weapons states, particularly the superpowers. Progress toward limiting this vertical proliferation and toward a test-ban treaty would bolster the NPT and produce a climate conducive to strengthening non-proliferation.

It recommends that Australia continue to accord high priority to active and constructive participation in disarmament and arms control negotiations, with a principal aim of concluding a comprehensive nuclear test-ban treaty.

In addition, Australia should promote the agreement between all parties to the NPT not to supply nuclear items to non-NPT states which do not have nuclear weapons, unless the safeguards of the International Atomic Energy Agency apply to those states’ nuclear facilities at all times.

Other recommendations include that Australia:
- continue to support proposals for a nuclear-weapons-free zone in the South Pacific and an Indian Ocean zone for peace.
- ratify the Convention on the Physical Protection of Nuclear Material and introduce legislation incorporating standards and measures for physical protection of such material being stored and transported here.
- continue to encourage the establishment of a scheme to regulate the storage and use of sensitive nuclear material, with provision for the IAEA to verify each country’s use of the material.

The report says most NPT countries comply with IAEA safeguards requirements and co-operate with safeguards inspections. But some NPT countries do not co-operate fully with the inspections, allowing the possibility that small amounts of nuclear material could be diverted.

“However, the safeguards system provides a high degree of assurance that a country would be unable to divert sufficient material to make an explosive device without the diversion being detected,” it says.

“If a country were determined to divert material, it is not likely that the threat of detection would be sufficient deterrent.”

To improve the effectiveness of the safeguards system, the report recommends that Australia provide further resources to the IAEA and encourage other countries to do the same.

It also recommends that every effort be made to maintain and enhance Australia’s influence in the IAEA by strengthening Australian credentials for
a seat in the IAEA board of governors; considering the creation of a separate mission to the IAEA and ensuring Australia is adequately represented in all discussions and negotiations; and making available well-qualified Australian candidates for significant and responsible positions in the IAEA.

Public confidence in the safeguards would increase if the administrative arrangements Australia has with its partners in bilateral agreements were made public, it says.

The report says there has generally been satisfactory compliance with producers to protect workers from radiation in uranium mining and milling in Australia, although there have been exceptions to this. It recommends that the relevant safety standards be reviewed regularly and observance of the standards be monitored.

It also recommends that the federal, state and territory governments ensure the safety and environmental monitoring aspects of mining and milling are soundly established and carried out, and that a national registry be established showing where radioactive tailings and waste have been disposed of. The sites themselves should be identified with long-lasting markers on the ground.

On waste management, the report supports containing and isolating the source of radioactivity rather than dispersing it through dumping in the ocean or on land.

It says Australia should ratify the Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter and join the OECD consultation and surveillance mechanism on dumping radioactive wastes at sea.

The concern of island and seaboard countries to maintain the South Pacific as a resource should be recognised and Australia should use its influence in international forums to urge other countries to prohibit or severely restrict ocean dumping.

Australia should also participate in scientific assessments of the safety of ocean dumping and support a moratorium on the practice until the assessments are complete.

While no country has yet disposed of spent fuel or high-level waste from civil nuclear programs, the report concludes that the technology for safe disposal is available, providing an optimum geological repository is found. It recommends that Australia support and encourage international research into high-level waste disposal, particularly for the Synroc waste form being developed at the ANU.

The report stresses the need for international collaboration in developing waste-management programs, but says: "We consider that Australia is not in any way obliged to accept for disposal the high-level waste resulting from the use of Australian uranium. Furthermore, we believe that Australia should not seek to impose particular strategies for waste management on countries using Australian uranium, but rather seek to encourage all countries to adopt the best practicable, rather than merely adequate, waste-management strategies."

From Engineers Australia

Scientists critical of Astec Report:

A group of Canberra scientists have urged Australians not to be overawed by the scientific credentials of ASTEC (the Australian Science and Technology Council) when considering its recently released report on Australia's role in the Nuclear Fuel Cycle.

"By its own admission, ASTEC extended its inquiry to include broad social issues which they are no better qualified to judge than any other well-informed citizen," said Dr. Geoffrey Davies, a spokesman for the group.

"It is inappropriate to characterise the Report's conclusions as 'objective' or 'scientific', since nobody could reach objective, scientific conclusions on such general social, political and economic questions."

While not questioning the scientific credentials of the Council, the group was critical of the Report for not making clear where the scientific input ended and where the social and political judgements began.

"If this were a Master's Thesis, I'd ask for the conclusions to be rewritten," said Dr. Davies.

As an example, the group cited the Report's contention that nuclear energy will be vital for the social stability of modern societies and the further implication that Australia's denial of uranium exports might lead to war. These conclusions depend on estimates of future energy demand, future technology and future social and political conditions. None of these things can be predicted objectively. Also, a nation's neighbours might regard nuclear power, rightly or wrongly, as the first step to acquiring nuclear weapons and a regional nuclear arms race might be triggered. Weighing up these issues involves value judgements."

The group comprises Dr. Davies (geophysicist), Dr. J.M. Dickins (geologist), Dr. Mark Diesendorf (mathematician and physicist), Dr. Ivan Johnstone (physicist), Dr. Ray Lindsay (physicist), Dr. Michael Raupach (meteorologist) and Mr. David Turbayne (political scientist).

MASSEY UNIVERSITY
PALMERSTON NORTH
NEW ZEALAND

Professor of Physics
A New Chair

The University Council invites applications from suitably qualified persons for appointment to the Chair of Physics in the Faculty of Science. The Professor will be expected to provide leadership in both research and the teaching of physics and biophysics at the University.

Present responsibility for Physics rests with the Dean of Science and a group of eight academic staff members. Teaching and research training are provided for the B.Sc., B.Sc. (Hons), M.Sc. and Ph.D. degrees in the Faculty of Science and for Intermediate students in Agriculture, Horticulture, Technology and Veterinary Science. It is expected that a Department will be formed when the Chair has been filled.

Applicants with research experience in any field of Physics may apply.

The present salary range for a Professor is $NZ42,354 - $NZ52,899.

Further details of the position, together with general conditions of appointment may be obtained from the undersigned with whom applications close on 6th October, 1984.

A.J. Weir,
REGISTRAR
BRANCH NEWS

NSW Branch News

The first May meeting of the N.S.W. Branch took the form of a visit to Plessey Electronics at Meadowbank, Sydney and was attended by approximately 40 members.

As many readers will be aware, Plessey Australia is among the world leaders in the technology of piezoelectric ceramics for transducers and sonar devices and is recognised as a "centre of excellence" by the Government. Our members were shown the piezoelectric manufacturing laboratory where the transducers (often based on the lead zirconate nickel nitrate system) are prepared from a mixture of raw oxides in a process which involves ball-milling, pressing, sintering and slicing.

The materials laboratory is involved in research on new piezo-electrics and in quality control testing and it contained a very impressive collection of equipment for X-ray diffraction, differential thermal analysis, differential scanning calorimetry, thermo-mechanical analysis, atomic absorption spectroscopy, infra red and ultra-violet spectroscopy etc.

Plessey is involved in the manufacture of the Barra Sonobuoy, a successful submarine detection system designed to be dropped from aircraft, and our party had the opportunity to inspect the Sonobuoy hydrophone assembly area.

In the hybrid electronic manufacturing facility our tour was shown some of the steps, including the automatic "laser trimming" of resistive elements, in the production of thick film circuits for use in devices such as miniature two-way hearing aids for the deaf. Every organization undertaking materials research regards a scanning electron microscope (SEM) as an essential item of equipment. Plessey's SEM is equipped with all the "bells and whistles" necessary to image a specimen in several modes and to carry out elemental analysis on small areas by using energy dispersive X-ray analysis. Members were shown results of investigations undertaken with the aid of the SEM. These ranged from the analysis of corrosion products to the inspection of "failed" ultrasonic welds between fine gold wires and micro-chips.

The visit was enjoyable and educational and the Branch appreciates the efforts of Ralph Davies in organizing the visit and of all the other staff members who acted as tour guides or who explained our work.

John Dunlop

The second May meeting of the NSW Branch of the AIP was addressed by Professor George Rathjens, Professor of Political Science, Massachusetts Institute of Technology, and was attended by some 50 members and guests.

Professor Rathjens is the Co-Director of the Programme in Science and Technology for International Security at M.I.T. Initially trained as a chemist at Yale and the University of California, from 1953 onwards he has spent much of his time in Washington with various Government Agencies. He has served on the staff of the Weapons Systems Evaluation Group of the Department of Defense and as Deputy Director of its Advanced Research Projects Agency. He has also been Deputy Assistant Director of the U.S. Arms Control and Disarmament Agency, and Director of the Systems Evaluation Division of the Institute for Defence Analyses. In 1979-80 he was Deputy to Ambassador at Large Gerard Smith in the Department of State.

Particular areas of interest have been adoption of technology for developing countries, communications, and environmental and energy problems. In recent years he has been concerned with nuclear energy policy and its relation to nuclear weapons proliferation.

In his talk, Professor Rathjens detailed the orthodoxy approach to defence policy, arms control, etc. This approach is essentially a belief in deterrent capability which while not necessarily desirable at least is effective. He then went on to present the Reaganauts view — "more is better". Present White House thinking does not distinguish between the capabilities of nuclear as opposed to conventional weapons. A new element in U.S. policy is that continual escalation of expenditure on nuclear weapons will eventually bankrupt the USSR! Professor Rathjens then went on to say that in his opinion, no treaties had ever been signed which would reduce the likelihood of nuclear war, save money, or reduce the effect of nuclear war. However, treaties such as those preventing the testing of nuclear weapons in the atmosphere did have positive environmental benefits. In his opinion arms control talks are unlikely to yield positive results. A more productive approach would be to negotiate on lower-level topics such as anti-satellite warfare and underground testing of nuclear devices. He stressed it was important to negotiate agreements that lessen local tensions, thus removing a source of conflict that has the potential to escalate into nuclear war. Finally, Professor Rathjens expressed a feeling of grave pessimism concerning the future.

Paul Hewitt

W.A. Branch News

This branch enjoyed two very interesting lectures both in line with this year's theme of Physics and Technology.

The first, given by Mr. J.E. Hayes, Assistant Commissioner for Development, State Energy Commission, had the title "Dampier to Perth Natural Gas Pipeline Project, Bulk Transport Considerations".

The talk addressed the salient features of the planning, design and construction phases of this large project with costs of $920 million. The project employed 2,000 people during its peak period. The criteria of choice for the pipeline route was explained together with considerations of land acquisition and the need to satisfy environmental requirements. A previously unknown site with Aboriginal relics was discovered and a huge causeway had to be constructed across the Dampier salt flats to site the pipe above the water table. The approach for optimising the design of the pipe with diameter of 666mm and 8.4 MPa operating pressure was discussed. Also the inside lining to reduce friction and outside fusion bonded coating to reduce corrosion were described. A 100% radiography check was carried out on the welding of the 12 metre sections with only 7% of all welds needing repairs. The control system SCADA was installed to enable the whole pipeline system to be operated and controlled from Perth and some parts from Karratha. It controls the nine compressor points and related safety mechanism as well as metering gear sold to customers. An interesting film on the construction of the pipeline terminated this talk.

The second talk was given by Professor Norman Abramson, professor of Electrical Engineering and Information Sciences, from the University of Hawaii. The title was "Communications Satellites In and Out..."
of Clarke Orbit”. Professor Abramson is the author of “Information Theory and Coding,” published by McGraw-Hill and co-editor of “Computer Communications” published by Prentice Hall. He holds several patents in the communications field and is on the Board of Directors of the Pacific Telecommunications Council, Honolulu.

He started his talk by defining the Clarke Orbit as the circular orbit in the equatorial plane of the earth with the trajectory travelling in the same direction as the earth with a 24 hour period. Thus, the trajectory is geosynchronous and from the earth’s observer geostationary, an ideal orbit for satellite communication with radius of 36,000km.

Modern electronic components with 10 year reliability he said, have made the satellite a reality and to overcome power problems during eclipses where the satellite is in the earth’s shadow solar cells and rechargeable batteries are required. With a starting weight of 427,000lbs in the original rocket, the satellite itself weighs only 680lbs. Its fuel (hydrazine) weighs 334lbs and its communicating technology weighs 400lbs making a ratio of 1:1000 for the useful component. There are now several groups launching satellites. Europe, Japan, USSR, India, U.S. Government and some private companies. One private company is charging $38m per mission. Insurance costs are enormous as the present failure rate is 10% to 20%.

To get world wide communication coverage a three ocean system would be required. Professor Abramson then encouraged us in Perth to consider the possibility of building a communication base here, because we occupy a very favourable geographically isolated position, giving us access to a large frequency spectrum. He ended his talk with very enjoyable comments on the legal implications of recovering these satellites which recently failed to attain the correct Clarke Orbit by asking who were the legitimate owners?

Both lectures were well attended and the “stay at home” members of the A.I.P. missed two stimulating evenings.

Trudi Thompson

**Victorian Branch News**

The first Victoria meeting for 1984 was held on 22 March, and was addressed by Dr. Erich Vogt, Director of TRIUMF (Tri. universities meson facility) in Canada. His subject was “Beyond the standard model” towards the Desertron and the next generation of accelerators”.

Dr. Vogt began his talk with a short review of what is now called the standard model of elementary particles and their interactions. (Reviewing reviews in a tricky business, especially for an incompetent reviewer, and I shall therefore not attempt it! For those wishing to get to the top and bottom of it all, and gauge for themselves just how successful the model is, I recommend the colourfully illustrated article “The Structure of Quarks and Leptons” by Haim Harari in the April 1983 issue of Scientific American.)

Economy of means, or more specifically, simplicity of explanation, is a guiding principle which has served us physicists well for many years now. We were all at ease when, towards the end of last century, there were apparently almost 100 different building blocks of matter, namely the atoms of the periodic table. However, by the mid 1930s we felt much more comfortable with a mere quartet of elementary particles, i.e. the electron, proton, neutron and neutrino. Alas, by the mid 1960s we had once again grudgingly come to recognize roughly 100 fundamental forms of matter, the hadrons. Then the quark model intervened, and each

and every hadron could be satisfyingly explained as a different combination of only three kinds of quark. Today we think that there are probably at least 18 different quarks, 6 leptons, and about a dozen bosons which act as force carriers between quarks and leptons. Clearly the time is ripe for yet another breath-taking simplification! But it must be emphasized that at the moment we do not have any firm evidence for sub-quark or sub-lepton structure. Experiments on leptons probing down to separations of order $10^{-26}$m have drawn a blank, and it is still not possible to examine an isolated quark. Since the standard model has been so strikingly successful in explaining all interactions at separations greater than $10^{-18}$m, some might think it a little churlish to demand even more! Just think about the difficulties of explaining how sub-particles might move inside a quark or lepton, and how they might interact with each other! Yet the lure of simplicity still urges us forward.

Three of the most important particle physics questions to be answered in this context are as follows:

1. Are there more than 3 pairs of quarks and 3 pairs of leptons?
2. The gauge bosons of the weak force (W+, W- and Z) are massive particles, approximately 100 times heavier than the proton. Are there still heavier bosons?
3. Are neutrinos really massless?

Present accelerators can create 500 GeV particles to collide with another 500 GeV particles, but to attempt to answer these questions, energies about 10 times larger are required. Extrapolating from past performances these energies should be achieved in about 5 years time, when particle accelerators 100 km in diameter may well be a reality. Present plans for the Desertron, probably to be built in Texas, of course envisage 20 TeV/20 TeV collisions.

Professor Jim Piper, of the School of Mathematics and Physics at Macquarie University, addressed our meeting on 3 May and we enjoyed a lively and strongly illustrated presentation on the subject “Lasers For Science and Technology”.

Numerous solid, liquid and gas laser systems exist today, their output wavelengths ranging from the near IR into the UV. However, the visible spectrum is still relatively sparsely populated by reliable CW lasers. The He Ne variety is probably the most common, although its output power and wavelength range are both rather limited. The Ar and Kr ion lasers operate mainly in the UV and green. He Cd CW lasers are available for low power applications in the violet and UV, and Nd-YAG in the IR. The hollow cathode He-Cd laser is being actively developed in many laboratories as an alternative to the He Ne system; its output is around the mW level in the red, green and blue, and lifetimes of order 10^6 hr have been achieved by Professor Piper’s group.

The most common pulsed lasers are members of the rare gas halide (RGH) family, e.g., XeF, KrF and ArF, or of the Nd-YAG family with its frequency doubled and frequency-tripled relatives. Electron beam excited RGH lasers were first reported in 1975, and the discharge excited form a year later, both operate in the UV. Initially they seemed promising as CW sources, but it soon became clear that the power required to initiate laser action was very high, limiting the pulse repetition frequency to a few Hz in static gas systems, and around 1 kHz for transverse gas flow. Commercial devices with mean powers in the range 10-20 W at 100 Hz are now available. The XeCl laser is widely used as a dye laser pump. A range of dyes has been developed such that output wavelengths covering the range 300-800 nm are attainable by direct pumping, the range being extended down to 160 nm by frequency doubling or tripling.
RGH lasers are themselves tunable over a small range (~1 nm) with linewidths less than 1 cm⁻¹. A master/slave oscillator system is used to lock the laser, yielding a high spectral brightness source. Raman shifting of the output is also possible, using molecular hydrogen as the active medium. Conversion efficiencies as high as 50% and 20% into the first and second Stokes orders have been achieved.

Recently, metal atom photodissociation based on RGH lasers has been investigated. Their high UV output is used to photodissociate simple metal compounds, leading to excitation of the metal atoms and strong population inversion over resonance lines. In this way, peak powers of several kW have been observed on the sodium D lines.

In the field of new lasers, the requirements of the atomic uranium isotope evaporation project at Lawrence Livermore Laboratory have stimulated (!) the development of the copper vapour laser. Although it yields comparatively low pulse energy, it can operate at pulse repetition frequencies up to 10 kHz and at mean powers up to 100 W. The relevant technology is well within Australian capabilities, copper and gold vapour devices currently being developed commercially by Quantex Optics in association with Professor Piper's group. Problems associated with the high tube operating temperatures have been overcome by the use of ceramic materials to confine the discharge.

I was intrigued to hear of the possible use of a gold laser in the photothermal treatment of cancer. It happens that a derivative of hemophyrin is preferentially absorbed in the vicinity of cancerous cells. It also happens that, when irradiated in the orange light from the laser, the hemophyrin derivative undergoes a chemical change which renders it toxic to the cancerous cells. This seems to be one of those rare cases where chance plays a beneficent role!

Our guest speaker on 31 May was Professor George Rathjens from the Department of Political Science, MIT, his talk being intriguingly entitled "Star Wars".

In March 1983 President Reagan delivered what is now known as his "Star Wars" speech in which he stated his belief that the time was ripe for the USA to develop a defense against nuclear weapons which would be 100% effective. (Note however, that the President did not specifically mention the development of a space-based defense). About 30% of male telephone callers responding to the speech agreed with the President; Professor Rathjens didn’t give any data for lady callers! Nowadays, according to Professor Rathjens, only two people believe that a "perfect" defense can be achieved, namely, the President himself and his Secretary of Defence! However, many believe that it is worthwhile to strive for this unattainable goal, if only because of the jobs which will be generated and the technological spin off expected from defense oriented research.

A typical missile reaches the top of the earth's atmosphere about 240s after being launched. One or more warheads (real or dummy) then travel through space towards the target, re-enter the atmosphere, and detonate or break up close to ground level. Provided we could react sufficiently quickly, we could afford to wait until a real warhead re-enters the atmosphere before destroying it. This approach has the advantage that we can differentiate between real and dummy warheads relatively easily in the atmosphere, using the Doppler effect; on the other hand, a 100% defense requires demands that we be ready to launch a warhead-destroyer from just about any point within our own territory. e.g. we couldn't defend Sydney from Melbourne, even if we so wished.

As an alternative, we might attempt to destroy the warhead in outer space, using satellites. We could detect its emergence from the earth's atmosphere by identifying its IR plume, provided of course we just happened to be "looking" in the right direction at the right time. But to ensure that we didn't miss even the occasional warhead we would need several thousand satellites! And how would we tell the difference between a dummy and the real thing? We could reduce to two or three the number of satellites required, by going out into space sufficiently deeply, but this would be prohibitively costly and would make the pointing problem even more difficult. We might use intense laser beams as our warhead destroyers, bouncing them off mirrors in space, but the pointing problem would remain.

The remaining possibility is to attempt to detect the launching of a missile within a few seconds of lift-off; presumably, if we knew the whereabouts of all enemy missile storage sites, we would need only a relatively modest number of satellites. But how likely are we to know all the storage sites? What if the missiles were kept constantly on the move by train or launched from submarines?

Professor Rathjens pointed out that, even if we had a 100% effective defense system, the energy could probably deliver it of very little value by destroying some of our detector satellites as his first move, and following up quickly with a missile launch from the then unwatched site. However, it is probably possible to develop an effective defense for limited areas, e.g. the missile sites, and an effective anti-satellite capability.

All the above is rather depressing. Obviously, in this context as in many others, prevention is better than cure, i.e. a better approach is to seek effective arms limitation agreements, and apply political pressure, to avoid conflict. Many people consider this approach hopeless. Professor Rathjens considers it one of the only ways in which progress can be made.

Bilateral Agreements

The Department of Science and Technology is seeking proposals for the 1985 Bilateral Science and Technology Agreements Program.

The Agreements, administered for Australia by the Department, are with the United States, Japan, the Federal Republic of Germany, India, the People's Republic of China and Mexico.

Support offered by the program covers travel and living costs for collaborating scientists. The Department provides funds to support seminars and workshops, developed specifically as co-operative projects.

Program selection will be made by an Overview Committee on the basis of scientific and technological merit. Priority areas will be biotechnology, marine science, biomedical, communications, information, advanced materials and manufacturing technologies. Projects in other areas will also be considered.

Closing date for applications from Australian scientists and technologists for activities starting on or after 1 July 1985 is 1 October 1984.

Copies of the guidelines containing details of application procedures are available from:

The Director
International Activities (Bilateral Science and Technology Agreements) Department of Science and Technology
PO Box 65
BELCONNEN ACT 2616
or direct phone (062) 644280

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The Hamilton Astronomical Society ten metre radio telescope project

About four years ago Ken Gledhill, a graduate student in Physics at Waikato University and sometime President of the Hamilton Astronomical Society, was encouraged by Professor Bruce Liley to embark on construction of a proto-type radio telescope receiver operating at 1.4 GHz. The focussing device was a 3 metre diameter former N.Z. Post Office microwave dish. The project was successful and demonstrated that modern GaAs FET technology can readily be used to produce low noise receivers operating in the GHz range at quite modest cost. The equivalent noise temperature of the receiver was demonstrated to be 200 K. (Gledhill, K., “The Design and Construction of a 1.4 GHz Radio Telescope”, M.Sc. Thesis University of Waikato, 1982).

On the basis of these results, and because of considerable local interest in radio astronomy, the construction of a larger 10 metre dish (giving approximately a 1.5 degree beamwidth) was advocated by Nicholas Jones, a physics graduate student at Waikato University. The Ministry of Works drafting office was persuaded to draw up plans and details for this. The provisional design was produced by June 1982, and the final assembled design was completed in April 1983.

The construction of the dish and associated structure was not a simple task. Many specialist skills were required, including accurate bending of long pipes, quality welding, and machining of large components for the hub. However, the Head of the Mechanical Engineering Division of the Waikato Technical Institute, Mr B. Morrel, offered to take on this task using it as a project, under close supervision, for training students in the related engineering skills.

As a result of suggestions from staff at P.E.L., Lower Hutt, we decided to mount the dish on a naval Bofors gun mount recently removed from a Navy frigate. The Navy donated two of these mounts (one being for spares), and these were delivered to Hamilton by Hawkins Construction Ltd. Fletcher Steel Ltd. generously donated most of the structural steel required to construct the dish. The Carter Observatory Board provided a grant of $1,000 towards the project, and this enabled site works to go ahead. These consist of a 3 m diameter by 450 mm thick reinforced concrete pad set in the ground, and a 3.6 m high by 1.2 m diameter reinforced concrete column for mounting the steering platform on. About 8 cubic meters of concrete was used. The labour was provided by volunteers from the Astronomical Society and by periodic detainees.

A large proportion of the costs of the project have been met by local companies and organisations, and in a very real sense it has become a community project. There has been a wide interest in the radio telescope project and a lot of good-will towards it.

It is intended that the radio telescope will be available to the general public from time to time to demonstrate aspects of astronomy and to create interest in the associated sciences. However, it is believed that it will also be a useful research device for amateur astronomers. We believe the device will generate many research projects.

One project is the mapping of the diffuse or broad radio sources which are largely inaccessible to present and proposed professional narrow beam instruments. For example, Dr. W.B. McAdam of the University of Sydney, Department of Astronomy has indicated that there are relatively few observations of diffuse sources, some of which appear to be variable over periods of weeks or months. Depending on the area and region of sources, and their variability, theories concerning the nature of galaxies and wave propagation in the interstellar medium could be tested.

A second project of potential interest has been suggested by our colleagues at Auckland Observatory. In this Observatory there has been an important and continuing optical study of flare stars. These are stars whose brightness can change, apparently at random, by up to four magnitudes in several minutes. Previous simultaneous optical and radio monitoring of flare stars has demonstrated that radio outbursts accompany optical flares. However, no optical flare larger than about two magnitudes appears to have been observed by radio. Professional radio telescopes are heavily committed and not often available for the long periods of monitoring required to catch a large flare. It is conceivable that our present radio telescope would be almost unique in the world in availability for extended periods of flare star monitoring.

The study of solar flares is another area of potential application of the telescope. It is hoped that the dish will be completed, tested, covered with mesh and mounted by March 1984. At this stage it will be steerable but not controlled to track sources; however it should have accurate co-ordinate readouts, and therefore be useful for transit measurements on a considerable number of sources. During the year a graduate student will work on developing a computer-based tracking and data acquisition system, thus making the device a versatile and flexible research instrument.

E. Bydder, N. Jones, C. Savage, Physics Department, Waikato University, & Hamilton Astronomical Society, from the New Zealand Physicist.

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If you would like to receive a specimen copy of CONPAPS, please contact Miss Bethany J. Mott, Editor, CONPAPS, Elsevier Applied Science Publishers, 22 Rippleside Commercial Estate, Barking, Essex, IG11 0SA, England.
BOOK REVIEWS


Solid state physicists are often crystallographers in disguise, and such people may find this text has a useful place on their shelves. The material covered ranges from strength of proteins to Brillouin zones, from bonding-electron densities to dislocations in crystals. These seemingly disparate topics are linked by the common theme of structure of solids, “structure” being interpreted in the broadest sense of the word. Thus, a short chapter on energy bands considers the structure of Fermi surfaces.

The price paid for such a broad coverage of subject matter is that the treatment of some areas is rather superficial. In one instance, namely the section on linear thermal expansion, the approach is also misleading in that the equilibrium atomic positions are defined through minimization of the potential energy, rather than the Helmholtz free energy. On the other hand, the subject of phase transitions is treated in greater depth. Throughout, there is an emphasis on the role of symmetry.

Briefly, the contents are as follows: an opening chapter on chemical bonding and crystal packing leads on to a survey of the various types of crystal structure, including superionic conductors, liquid crystals, and large biological molecules. Chapters on energy band structure and lattice dynamics follow and the concluding chapter is on crystal lattice defects and twinning. An index is not included and some obvious references are omitted.

In freshness of approach I rate this book above the general level of crystallographic texts and look forward to the appearance of the remaining two volumes.


That ubiquitous phenomenon electromagnetic induction occurs at the surface of the earth in a rich variety of forms. Depending as it does on rock properties, and especially electrical conductivity, it is of prime importance to geophysicists in their work of determining the structure and composition of the earth from surface observations. Electromagnetic induction occurs continually at the earth’s surface on a global scale due to electric currents which flow external to the planet and form natural source fields. Electromagnetic induction is also caused to occur on smaller more local scales, with man-made or artificial source fields, in projects to determine local conductivity structure and in particular to search for electrical conductivity ‘anomalies’ which could indicate the presence of valuable ore deposits.

This book by James Wait is an expert treatment of the theoretical bases of the artificial-source-field range of problems. The text is impressively self-contained and thorough, and one gets the clear message that the book has resulted from Wait’s move some years ago from research institutions in Colorado to teaching departments at the University of Arizona; the book has all the attraction of a class-tested set of lectures and examples, at graduate level. As such the text flows more smoothly than might a monograph aimed at summarising the latest state of the art, for coming from a master of the subject with thirty years experience it is confident and competent indeed. Applications of the theory are described in some detail, but the book stops short of including any case history examples of results actually obtained in the field.

The development of the subject is elegant and rich with important formulae and derivations. Starting with direct current phenomena, and then a quasi-static approach to induced polarization, the text moves on to induction between non-grounded loops, to coupling with grounded sources, to vertical current sources, to a chapter on magentoteluric theory (based on natural source fields), to conclude with a chapter on inductive transients. The list of references at the end of each of the seven chapters acts as a bibliography sufficient to point the reader in the right direction, for further enquiry into the literature. The author mainly refers to the North American work with which he is most familiar, but pleasingly Australian work (having originated particularly from Macquarie University and CSIRO Mineral Physics) is well reported. There are two appendices, on important and relevant theory.

The book is well printed, an achievement for one containing much mathematics, and attractively bound. The figure pencilled inside the hard-cover of this reviewer’s complimentary copy was $34.00, at which price it is value indeed. I would say the book is a must on the shelves of everyone in Australia connected with the theory of electrical exploration geophysics.


In recent times general relativity has moved from being an esoteric outpost of physics to becoming a vital part of the physicist’s armoury. As a result, courses in the subject are well attended and there is a great demand for good introductory texts. There is in fact no shortage of such books, but most of them have very serious shortcomings. Worthy old classics such as Pauli, Eddington, Bergmann, Schrodinger and Moller present the subject as though ossified in the first few years after Einstein’s paper and really do not even give a hint of the modern flavour of the subject. Nowhere in these works will the reader find mention of black holes, cosmology, gravitational waves — those areas in fact which have breathed new life into the theory in the post-war years. Of more recent works, the massive fourteen hundred page tome by Misner, Thorne and Wheeler is oppressive by its sheer bulk, while Hawking and Ellis’s admirable book “The Global Structure of Space-Time” is too specialized to serve as an introductory text.

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Somewhere in the middle is Synge's turgid account, a compulsory read for students planning to specialize but hardly to be recommended for their initiation.

In the light of all this it is a pleasure to be able to report that in Stephani's slim volume we have something of a milestone. It is indeed remarkable how much can be achieved within such a few pages while sacrificing little in clarity and depth. The reader is assumed to have no prior knowledge of tensors or differential geometry yet by page 100 he is exploring the intricacies of the Schwarzschild solution. Everything after this is a pure bonus over some of the older texts. Stephani goes on to discuss the linearized approximation, gravitational waves and the highly important initial value problems. This is followed by a very nice chapter on exact solutions, including a discussion of Killing vectors and the Petrov classification. This area is Stephani's speciality and it is very encouraging to see a chapter on this important subject, since so many books give the impression that apart from Schwarzschild there are no other interesting exact solutions to be had. The last two chapters deal with the physically fascinating topics of black holes and cosmology. This covers most areas with which the serious student of relativity should become familiar. Not all topics are covered in complete detail, but the work is well referenced to enable the reader to explore matters further. Perhaps my only misgiving is that Stephani treats tensors and differential geometry in a fairly old-fashioned coordinate minded way, whereas nowadays it is advisable to have some inkling of more modern presentations of the mathematical background. However, it is too easy to be carried away with modernism at the expense of clarity and he has probably erred wisely in favour of the more classical approach. All in all, an excellent text book which should provide a great help in designing courses on the subject, and one which I will probably find myself referring to frequently in the years to come.

PEOPLE

Macquarie Scholar Honoured

Macquarie University's most distinguished scholar, Professor John Clive Ward, received the prestigious 1983 Hughes Medal at the University on 10 May.

In presenting the Royal Society medal and diploma, the British Consul General in Sydney, Mr K.S. Berthoud, said that Professor Ward, Fellow of the Royal Society, had received the medal in recognition of his highly influential and original contributions to quantum field theory, particularly the Ward Identity and the Salam-Ward theory of weak interactions.

His work ranks in importance with Maxwell's theory of electromagnetism and the quantum theory due to Einstein, Bohr, Heisenberg and others in explaining the fundamental properties of matter.

Professor Ward is only the third Australian (after Sir Marcus Oliphant and Joseph Pawsey) to receive the Hughes Medal, which was established in 1902. Previous recipients of the Hughes Medal include A.H. Compton, Enrico Fermi, Sir Harrie Massey, Vincourt Cherwell, Freeman Dyson and Sir Martin Ryle. Many recipients have also become Nobel Laureates.

On accepting the medal Professor Ward stated that, in general, he did not approve of medals — 'many as I regard it as self-advertisement. People should not need that sort of recognition from staff and students; people should be recognised for their own intrinsic talents.'

There are a lot of people, he pointed out, who collected honours and medals and then sat on their laurels. 'They do what they want to and expect to get paid for it regardless of its use to science or its social value.'

Professor Ward was also highly critical of the 'publish or perish' mentality of many universities. That sort of attitude, he said, prevented the very best of scholars from getting on with research that could not stop for publishers.

To counter arguments that Macquarie was a second rate University with little standing in the science community Professor Ward had requested that the medal be flown to Australia and presented at the University.

'I wanted to give Macquarie an opportunity to show that it has scientists on its faculty of world class.'

After obtaining his DPhil in Theoretical Physics at the University of Oxford in 1949, he spent periods as professor at various American universities including Princeton, Maryland, Miami, Carnegie Tech., and John Hopkins.

He was appointed professor of Physics at Macquarie University in 1966.

'I chose to come to Macquarie because I believed it was doing something different and exciting with its teaching and students.'

It was a long time before Professor Ward received international recognition for his work. After being elected a fellow of the Royal Society in 1965 in recognition of his contribution to theoretical physics, he had to wait until the 1980s for world recognition.

In 1981 he was awarded the Guthrie by the Institute of Physics in recognition of his outstanding contributions to theoretical physics, particularly in field theory renormalisation, statistical mechanics and in the unification of weak and electromagnetic interactions.
In 1982 the American Physical Society and the American Institute of Physics awarded Professor Ward the Dannie Heineman Prize for Mathematical Physics. The citation for the prize reads: for contribution to Mathematical Physics especially in renormalisation theory and gauge theories of elementary interactions.

The Vice-Chancellor, Professor Edwin C. Webb, pointed out that many people on campus were not aware of the scholar they had among them.

I am glad of the opportunity to express the University's own regard for the man who has been here since the inception of the University and who retires at the end of this year.

'He has been a stimulus and a leader in the School of Mathematics and Physics and in the University as a whole,' Professor Webb said.

University News Macquarie

PHYSICS ROUNDBOOUT

Astronomers detect galactic collision

Astronomers with ANU's Mount Stromlo and Siding Spring Observatories have detected a galactic collision in progress in the neighbourhood of the Milky Way, 10 million light years from Earth.

Dr Bill Peters and his co-workers are using the CSIRO's twin element aperture synthesis radio telescope at Parkes to carry out observations on the collision. The instrument has a pair of antennae, one of which is movable and can be set some distance from the other. This separation provides enormous resolution, some 25 times greater than for a single radio telescope.

It has enabled Dr Peters to detect the motion of atomic hydrogen gas in the galaxies. As a rule the internal motion of galaxies forms neat swirls, but during a collision this motion is thrown into disarray. Other evidence which can be observed is streams of hydrogen gas, trailing off from the area of impact.

While it is certain that a collision is in progress, it is not clear whether the large galaxy will cannibalise all of the small one, or merely a fragment of it.

According to Dr Peters, the galaxies are in the constellation Reticulum in the southern part of the sky and are not visible from the Northern Hemisphere. He said the value of the observations currently being undertaken would depend largely on how violent the collision was found to be, and the amount of disruption caused.

Because the collision was taking place 'relatively close at hand' — though well out of our own star system — it was of particular interest as it could be studied in detail. Collisions within our own system were harder to study, due to a limited view within the dusty galactic disc. Being able to observe a collision taking place nearby could assist in understanding collisions affecting our own galaxy.

Other interesting facts might result, Dr Peters said. For instance, there was always the hope that some evidence could be found to help solve the problem of 'missing matter'.

Put simply, this is the problem caused by a discrepancy between the amount of mass found in galaxies by counting stars and the mass determined from the speed of their orbits.

Essentially, there is a 'mass weight anomaly'. The discrepancy can only be accounted for by supposing that there are huge amounts of 'non-luminous' matter, invisible due to their lack of light.

It is thought that the disruption caused during galactic collisions could help to stir things up, perhaps providing some indication of the position of this unaccounted for mass.

The colliding galaxies, showing the dwarf galaxy at the bottom right merging with the larger galaxy. The photograph was taken through the Anglo-Australian Telescope at Siding Spring.

It is hoped that the information provided from viewing the event will also give additional elaboration to the current theory which suggests that the evolution of galaxies is based on the process of collision and cannibalisation of small star systems by larger ones.

Dr Alex Rodgers, a Professorial Fellow at MSSSO, became involved with the development of this theory several years ago when he established evidence of a collision taking place between a small galaxy, like our neighbouring Magellanic Clouds, and the Milky Way. From the collision there was produced a whole generation of new stars.

He says there is accumulating evidence from around the world that this kind of event led to the beginning of the formation of our own galaxy around 15 billion years ago.

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problems, are hyperactive or are frightened and thereby incapable of cooperating with medical staff.

The technique involves inserting a needle electrode, under general anaesthetic, through the eardrum and into the close proximity of the cochlea (the hearing organ of the ear).

The equipment consists of one part which records the responses (electrodes, amplifiers, filters, averager, display and permanent recording devices), and a separate part which provides the necessary sounds to evoke a response from the nerve of hearing.

The machine actually does the hearing for the child; it records the cochlea's response to sound and a computer analyses it without the patient having to cooperate.

The child's response to sound is thus detected and the technique provides an accurate picture of the auditory function of the cochlea and the information obtained helps to locate the actual site of the auditory dysfunction.

The equipment, also fulfills another function. It records the auditory brainstem evoked response, which assesses the integrity of the nervous pathway to the brain. These two techniques are most useful in cases where it is very important to investigate a child's hearing when no other technique has been successful. They are also useful in adults where various otoneurological conditions are indicated.

Science policy committee discusses municipal nuclear free zones

The topic of municipal nuclear free zones received special attention at the June meeting of the AIP's Science Policy Committee in Sydney. Dr Keith Suter from Wesley College, Sydney University, addressed the Committee as invited speaker.

Dr Suter told the Committee that while the term international nuclear free zones was fairly well understood, the notion of nuclear free zones as put forward by some municipal councils was less precise. Speculation about the probability of limited nuclear war has increased the momentum of the arms control debate over the last few years. The interest in municipal nuclear free zones contributed to this as they filled the role of a consciousness raising activity and provided a way of supporting Government's policy initiatives. The concept itself has no legal significance and local councils approach it in different ways, the Committee was told.

Some Committee members expressed concern that the concept seemed to be anti-science in general and did not adequately accommodate work such as nuclear medicine. While Dr Suter acknowledged the concerns of these members, they felt that there could be problems with the concept being over-simplified when it is presented to the public.

Dr Suter went on to tell the Committee that he thought that the Institute had an important role to play in raising the level of social responsibility of its members over the arms race.

Dr Suter saw the Institute's major role as educational and assisting the circulation of information on the arms race to AIP members and the public. The current explosion of concern over disarmament has meant that there is a general lack of accurate scientific information.

— AIP Science Policy Committee

Measuring Hearing Loss

Macquarie University expertise and equipment has been used to pioneer a technique to investigate hearing loss in children in Australia.

The technique, known as transystympanic electrocochleography, has been in use overseas for some time, but the lack of equipment and suitably qualified personnel has precluded its introduction in Australia.

The technique is used in cases where a child's hearing is impossible to assess using the more conventional methods. It is particularly useful with children who are multiple handicapped, have severe behavioural

Peter Quiddington, ANU Reporter
CSFP/AEAP Visiting Fellowship 1985/86

Submissions are now being invited from educational institutions and organisations seeking to nominate distinguished overseas scholars and educationists to visit Australia under the above schemes in 1985/86. A small number of Visiting Fellowships is available during 1985/86 under the Commonwealth Scholarship and Fellowship Plan for experts from Commonwealth countries and the Australian-European Awards Program for experts from European countries.

It is expected that preference will be given to proposals which supply detailed information regarding specific activities in which the Fellow will participate while in Australia, and which demonstrate that the program will be of mutual benefit for both the Fellow and those Australian colleagues involving themselves in the visit.

The closing date for receipt of submissions is 1 September 1984. Further information is available from D J. Bradley, Secretary, Visiting Fellowships Selection Committee, Commonwealth Department of Education and Youth Affairs.

Optical-fibre link for Sydney-Melbourne

Planning is well advanced for the new optical fibre cable which Telecom is to lay between Sydney and Melbourne.

The project, which will cost more than $40 million, is a major step in Telecom's plans to provide a national integrated digital network by the end of the decade.

The cable is to be laid over the next two years and be ready for service by 1988. It will have 30 optical fibres carrying 60,000 voice channels or a mix of voice, data and television channels.

The existing coaxial cable connecting the 2 cities carries only 9000 channels. It was laid in 1962.

Announcing the new cable, Telecom general manager Bill Pollock said it will be a digital system complementing the present broadband systems.

The route will follow that of the coaxial cable through Canberra, Wagga and Albury. Surveyors have already begun working along the route.

Where possible, existing above-ground repeater stations will be used for the new cable. But only about every third station will be needed, since optical systems can go much further between repeaters than coaxial cables.

High stability thermocouple is developed in Australia

A new high-quality-performance base-metal thermocouple has now, more than 2 decades after development work began in Melbourne, received official international recognition.

The thermocouple, used for precise process temperature control, has been standardised by the Instrument Society of America. It will be known as type N thermocouple.

Its thermopositive element is a nickel alloy containing 14.2% chromium and 1.4% silicon. The thermonegative element consists of nickel with 4.4% silicon and 0.1% magnesium.

Developed at the high-temperature properties group of the Defence Department Materials Research Laboratories in Melbourne, its main advantages are a high thermoelectric stability at temperatures of up to 1250°C and a design life longer than that of other base-metal thermocouples.

"In some high temperature applications the couple has proven to be an effective substitute for noble metal couples which are about 60 times more expensive," said the system's inventor, Dr Noel Burley.

Burley wasformerly head of the high-temperature properties group and is now development manager with Bell Instruments.

The alloys used have shown high resistance against corrosion in aggressive environments such as hot air, molten chloride and nuclear radiation, he said.

The alloys can also be manufactured easier than, say, those of the standard type K couple which has a similar thermal emf output.

The chemical composition is fixed and can be reproduced without metallurgical problems, said John Hobson, senior engineer — systems and energy management at the Department of Defence Support's resources division in Melbourne.

Hobson has been involved in promoting the thermocouple for a number of years. Because of its robustness and output stability he sees a particular application in military aircraft jet-engine control.

The thermocouple could help improve engine performance and extend engine life, thus potentially saving the RAAF a lot of money, he said.

In fact, the RAAF is about to start comprehensive tests using the type N thermocouple to measure turbine inlet and jet tailpipe temperatures.

So far, type K couples have been used for this purpose. But their thermal instability often caused false readings lower than the actual temperatures.

Since precise control of the operating temperature is believed to be a crucial factor for preventing hot corrosion of the turbine blades, the RAAF hopes the new thermocouple will help reduce this type of corrosion.

Hobson said a few Australian organisations are already using the type N couple commercially.

A Victorian tile manufacturer uses it for its process control up to 1300°C. Another company controls with it heat treatment baths for special alloy steels, and a wheat de-infestation plant operating at temperatures between 65°C and 130°C has also found it useful.

The first industrial evaluation in Australia was conducted in 1979-80 at an ordnance factory in Maribyrnong, Victoria.

Overseas, particularly in the US and Japan, Hobson said, the thermocouple has been tested and is being used on a much larger scale.

The first known industrial test in the US took place as early as 1974. It was carried out at IBM's general products division in California.

As a result the company has now converted more than 70 production furnaces to the type N couples.

Hobson said IBM reportedly has saved several hundreds of thousands of dollars by avoiding frequent thermocouple replacements or recalibrations. Production yields have also improved substantially.

According to inventor Burley, recently completed tests at the Windscale nuclear power reactor in Britain have been successful, too. The thermocouple was used in an environment of carbon dioxide gas and an unspecified intensity of neutron irradiation.

The UK Atomic Energy Authority reported that no reasons had arisen to doubt the couple's calibration validity throughout the tests. — Engineers Australia
Large lump of space junk could become gamma-ray telescope

American scientists are planning the most ambitious piece of scrap metal recycling ever attempted. They want to turn the space shuttle's 30-tonne external fuel tank into an orbiting space telescope.

At present the $20 million tank, which carries liquid hydrogen and oxygen, has useful life of less than five minutes — the time between blast off from Cape Canaveral and the moment when it is jettisoned as the shuttle leaves the Earth's atmosphere. The tank, known to scientists as ET, then falls back towards the Indian Ocean.

Several uses have been suggested for the 50 m piece of space junk, ranging from an orbiting fuel station to an astronauts' hotel. Now, Mr David Koch of the Harvard Smithsonian Astrophysics Observatory Cambridge, Massachusetts, says he could turn it into a telescope. Not to look at ordinary starlight but as a highly sensitive instrument to detect gamma rays.

The full rainbow of electromagnetic radiation covers a much wider spread of wavelengths than the colours we can see with our eyes. From radio waves, through infra-red, visible and ultra-violet light, it stretches to X-rays and, at the most energetic edge of the rainbow, gamma rays. They come from violent events in the universe: exploding stars, fast-spinning neutron stars and black holes. They interact with the atmosphere to produce a shower of new particles, and cannot be detected directly on Earth.

The first detectors in space did little more than prove gamma rays were there. Even today, only 25 specific sources are known, and only two of those have been located with enough precision to find their visible counterparts. Later this decade, the shuttle will launch a satellite called the Gamma Ray Observatory (GRO) which will vastly improve our knowledge of gamma-ray astronomy. But even when it was proposed, the U.S. National Academy of Sciences emphasised an even bigger telescope would soon be needed. ET could provide the basis of such a device.

All important is the collecting area of the detectors. The best to date, in Europe's Cos B satellite, was the size of a book. GRO's could be compared with a coffee table. The detectors in ET will cover the area of a two-car garage. Additional components, carried on the shuttle's cargo bay to avoid the stresses of launch in the tank, will actually be lighter than the GRO satellite.

Space scientists regard ET as ideal for transformation into a telescope for a variety of reasons:
- It is large, thin walled, gas-tight, light-weight, insulated and rigid.
- Since the delivery into space is essentially free the new telescope would be cheap to make ready.
- The telescope must be housed within a pressure vessel at only a few pounds-per-square-inch. ET is designed to operate up to 40 psi — ideal pressures.
- This pressure level would ensure the tank wall would not significantly absorb gamma rays or become a source of secondary gamma rays due to high energy cosmic ray interactions.

There will be room for a commercial payload on the same mission. Few modifications to ET on the ground are needed — a few internal supports for telescope components and a thin outer skin of aluminium for protection against meteorics. Most of the conversion would be done in space. Mr Koch believes six astronauts, using the manned manoeuvring units proved on the last flight, could do all the work in seven days.

Gamma rays will enter the thin-walled tank unimpeded. They are not detected directly, but converted into pairs of high-speed, charged particles by a sheet of lead foil known as a trigger module. That is sandwiched between two scintillators, sheets of transparent plastic, in which the charged particles cause a flash of light that is picked up by phototubes. Particles from gamma rays will only produce a flash in the layers below the lead. The body of the tank will be filled with gas, and as the particles speed through it, they will send out cones of so-called Cherenkov light. The ultra-violet light can be focused onto an array of photo-multiplier tubes by a huge mirror spanning the tank. Another scintillator, the time-of-flight module, behind the mirror, spots the particles to check they have come from the direction in which the telescope is pointing. The astronauts will also install equipment to point the telescope, to power it and relay its findings.

Martin Redford.
Astronautical Society of W.A.
— News Bulletin

Scanning the eye

In the search for less invasive ways of detecting disease in patients, Britain's Atomic Energy Research Establishment (AERE), at Harwell near Oxford, has developed an advanced imaging system for the ultrasonic eye scanner at Moorfields Eye Hospital, in London.

The scanner was originally developed at Harwell around ten years ago and is used in the clinical diagnosis of eye disorders.

It operates by passing a low energy pulsed beam of ultrasound across the eye. From the reflected signals (A scans) an image of the anterior structure of the eye can be built up. This is presented as a cross-sectional image along a selected plane, allowing the detection of any irregularities such as retinal detachments or tumours. It also shows the effect of eye movements.

The new imaging and recording system was developed at the AERE's non-destructive testing centre. It displays directly on to a television screen so that the image can be recorded on standard video tape.

The video can be replayed during later diagnostic sessions, used as a guide during surgery and stored for reference as treatment proceeds.

It will also be used to provide teaching material at Moorfields, Britain's principal ophthalmic hospital.

The system is built around a powerful LSI 11 computer, which has access to other ultrasonic data so that further computer image analysis is possible.

The image processing system comprises a dual memory unit in which digitised ultrasonic data are continually captured and transferred to a temporary store. Subsequent processing involves co-ordinated plotting and transfer of data to a picture store for manipulation and display.

The Australian Physics, Vol. 21, August 1984 — Page 172
Australian scientists involved in new space technique

As the next space shuttle flight in October this year broadcasts radar waves on a 100-kilometre front over the ocean's surface, a University of Sydney research group will be measuring surface conditions to find out more about the reflection of radar from water.

With five years' experience in analysing oceanographic data from satellites, the Sydney group will play a vital role in assisting NASA scientists to interpret radar images of the sea, which are not fully understood.

A spokesman for the group, Dr Ian Jones, says radar reflects from the ocean surface in different ways according to the turbulence of the water, different patterns giving distinctive 'signatures' of events beneath such as currents, eddies and internal waves.

The information is valuable in building an understanding of ocean behaviour, in weather forecasting and navigation, and could have commercial applications such as geological exploration, which is already an important aspect of radar images of the ground.

Annual Reviews at a Discount

Annual Reviews Inc, the non-profit scientific publishers, are offering back copies of their publications at a considerable discount (typically 50%). Of particular interest to physicists are the Annual Reviews of Astronomy and Astrophysics, Earth and Planetary Sciences, Energy and Nuclear Particle Science. Further details from Annual Reviews Inc, 4139 El Camino Way, Palo Alto, California 94306 USA.

Allende meteorite leads researchers to supernova 'stardust' discovery

Scientists at the ANU who have been analysing the composition of meteorites are among the first to have identified materials formed by exploding stars long before our own sun came into being.

Meteorite particles which they have examined using a new ultra-high-precision mass spectrometer developed at the University have been shown to predate the formation of the solar system and to be composed of the debris of immense supernova explosions far out in the Galaxy.

The researchers, Dr Tezer Esat, a Research Fellow in the Department of Nuclear Physics, RSPS, and Dr Ross Taylor, a Professorial Fellow in the Research School of Earth Sciences, are now searching for additional clues about the record of events relating both to supernova explosions and to the formation of the solar nebula from which the sun and planets condensed.

Dr Esat said: 'We are at the beginning of a very exciting program which will attempt to seek out, enumerate and label the events that have occurred at the very beginnings of the solar system.'

The new high-precision mass spectrometer that has made this research program possible was developed jointly over the past four years by the Department of Nuclear Physics and RSES.

The main motivation for devising the instrument was a sudden upsurge of world-wide interest in some puzzling variations which had been discovered in the composition of meteorites — particularly the large Allende meteorite, weighing several tonnes, which fell in Mexico in February 1969. According to the ANU researchers, this has proved to be the marker event for a decade of discoveries which have altered scientists' views on the events leading to the formation of the solar system.

The reason for this is that material from Allende has been associated directly with specific nuclear processes occurring in stars. This means that for the first time, scientists are able to test theories and calculations relating to the formation of elements in stars.

Most of this information has been obtained through the measurement of elements in 'inclusions' scattered throughout the body of the meteorite. These inclusions, which range from a few millimetres to a few centimetres in diameter, are roughly spherical and consist of refractory crystals containing elements such as magnesium, aluminium, calcium and titanium.

The Allende inclusions have been found to have two distinct types of isotopes (atoms of the same element, but containing different numbers of neutrons in their nuclei). One of these types involves elements which are the product of radioactive transmutation, while the other consists of the elements derived from nuclear synthesis in stars.

Most elements on earth, and in the extra-terrestrial materials, scientists have access to, have isotopes with a fixed ratio to each other. In contrast, samples from the Allende meteorite currently being analysed by the ANU research team have been found to have unique isotopic patterns clearly indicating that they have originated in some distant star.

Dr Taylor says that previous geochemical work on these inclusions at RSES had established a complex history of condensation, evaporation and re-condensation in the presolar nebula. This evidence was established on the basis of peculiar abundance patterns of the rare earth elements, unlike any previously observed on earth, the moon or in other meteorites.

Isotopic analysis in the new mass spectrometer of magnesium found in the Allende meteorite has now revealed variations in the isotopic record in microscopic
individual grains. This, the researchers say, is contrary to all previous findings and indicative of the expected characteristics of preserved interstellar dust grains.

From this they have concluded that the individual grains making up the inclusions must have come from separate regions of interstellar space and must be the separate products of several different stars.

These findings by Dr Taylor and Dr Esat aroused considerable interest among other scientists when they were presented at the Lunar and Planetary Science Conference held in Houston, Texas, earlier this year. Already, similar research projects have been initiated at laboratories in the United States and Europe for further examination of the Allende material.

The mass spectrometer that has helped to make these discoveries impossible was manufactured at the ANU using an 11-tonne magnet previously used in conjunction with the university's nuclear accelerator. From a nuclear physics viewpoint the magnet had become obsolete, but it represents a major advance in comparison with previous magnets used in mass spectrometers.

Dr Taylor and Dr Esat say the results achieved by the new spectrometer have exceeded even their expectations. They add that for the foreseeable future it will remain the premier instrument of its kind in the world, unrivalled in speed and precision.

‘Previously, the details and nature of the element synthesis in stars were deduced from experiments done in nuclear physics laboratories by trying to imitate the nuclear reactions going on in stars,’ says Dr Esat.

‘In contrast, I can now hold a small vial in my hand with a few crystals in it and claim that I know that the material in it is a direct product of an exploding star, manufactured during a brief few seconds as it was blowing itself to bits and spreading this material out into space, and I can also say something about the nuclear processes occurring during this time. And that is a great deal to say.’

Dr Esat adds that comets represent another promising area in the search for materials predating the solar system. Comets consist of volatile ice and dust. They are thought to have been formed in a cold environment and preserved in deep space in unaltered form for billions of years.

Minute particles believed to be cometary debris are constantly falling into the earth's atmosphere. Scientists at the United States National Aeronautics and Space Administration (NASA) have been collecting these particles for analysis. They are swept up and caught on ‘sticky tape’ carried on high-flying U2 aircraft.

The ANU researchers recently received a batch of nine of these particles. They are analysing them to determine the isotopic pattern they contain of the element, magnesium.

‘Discovery of extra-terrestrial isotopes in the particles will reinforce the speculation about their cometary origin,’ says Dr Esat, ‘It will also provide further incentive for an intercept and sample return mission to a comet.

“No other mass spectrometer is capable of providing such an analysis of these particles. Our analytical techniques have to be so precise that they go beyond the methods used even on the analysis of lunar rocks.”

—from the ANU Reporter

Tiny particles of extra-terrestrial dust, thought to be debris from disintegrated comets, which have been collected on 'sticky tape' by high-flying U2 aircraft. Each particle is about one hundredth of a millimetre in diameter. The spherical particle at left is known in NASA parlance as a 'cosmic strawberry'.

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Conferences and Meetings

1984
P. van Binst, Univ. of Brussels, c.p. 230, bd. du Triomphe, B-1050 Brussels

Sep. 11-14 Physics and Chemistry of High Condensed Matter, Aussos, France
J. M. Benson, Physique des Milieux tres Condenses, Tour 13 E.4, Universite Paris VI, 4 place Jussieu, F-75230 Paris Cedex 05

Dec. 3-6 9th Australian Conf. on Optical Fibre Technology. Wollongong LI Hall. Dept. of Science and Technology. P.O. Box K 701, Haymarket NSW 2000

1985
Peeka Lahtil, Department of Physical Sciences. University of Turku, SF-20500 Turku 50

June 17-22 10th Int. Workshop on Weak Interactions, Savonlinna, Finland

July 1-6 International Conf. on Nuclear Physics: Intermediate Energy Nuclear Physics with Electromagnetic Probes, Paris, France
A. Gerard & C. Samour, DPhN/HE, C.E.N. Saclay. F-91191 Gif-sur Yvette Cedex

July 14-19 Fourth Meeting of The World Federation for Ultrasound in Medicine and Biology. (WFUMB'85)
Contact: Secretariat, P.O. Box 1441, G.P.O. Sydney NSW Australia

July 20 Fourth International Congress on the Ultrasonic Examination of the Breast. Contact:
The Secretariat, International Breast Congress. University Department of Surgery. Royal North Shore Hospital, St. Leonards, NSW 2065 Australia

Aug. 4-18 International Summerschool on Nuclear Structure on: “Frontiers in Nuclear Dynamics”. Dronten. The Netherlands
PA de Witt Huberts, NIKHEF-K. PO Box 4395. NL-1009 AJ Amsterdam

Aug. 20-23 FLOMEKO-85 (International Conf. on Flow Measurement). Melbourne University Dr. B.B. Sharp, Civil Engineering Dept., University of Melbourne. Victoria

THE UNIVERSITY OF ADELAIDE
invites applications from both men and women for the following positions:

LECTURERS IN PHYSICS
(Tenurable — 2 Positions)

(Ref A1781, 1769) Applicants should have a commitment to excellence in teaching and research, and experimental or theoretical experience relevant to one of the research fields of the Department. Duties will include undergraduate teaching, postgraduate supervision and research.

The major research interests of the Department include: Atmospheric Physics, Atomic and Molecular Physics, Condensed Matter Physics, Cosmic Radiation (including high energy gamma-ray astronomy), Physical Archaeometry, Seismology, and Theoretical Nuclear and Particle Physics.

These positions are available from 11 February 1985.

Detailed information about the Department can be obtained from the Chairman, Dr. W.G. Elford (09) 226 5231. An academic review of the Department is in process.

Holders of full-time tenured or tenurable academic appointments have the opportunity to take leave without pay on a half-time basis for a specific period of up to ten years where this is necessary for the care of children.

It is University policy to encourage women to apply for consideration for appointment to, in particular, tenurable academic positions.

FURTHER INFORMATION about the general conditions of all appointments may be obtained from the Senior Assistant Registrar (Personnel) at the University.

SALARIES per annum $24,353 x 7 — $51,994 (Subject to review)

APPLICATIONS, in duplicate, with full particulars and reference numbers and giving full personal particulars (including residential status), details of academic qualifications and names and addresses of three referees should reach the Senior Assistant Registrar (Personnel) at the University of Adelaide, GPO Box 498, Adelaide, South Australia 5001, Telex UNIVAD AA 89141 not later than 30 September 1984.

The University reserves the right not to make an appointment or to appoint by invitation.

CSIRO
RADIO RESEARCH BOARD
AUSTRALIA
POSTDOCTORAL FELLOWSHIP

GENERAL: As part of its activities designed to foster research in electronics, telecommunications, radio science and related fields in the universities and other appropriate organizations, the Radio Research Board offers a Fellowship scheme. Under this scheme Fellowships are awarded annually for full-time research by young scientists or engineers of exceptional promise and proven merit. These are Postdoctoral awards tenable for a period of two years in an Australian university, approved research institute or industrial laboratory as determined by negotiation between a prospective Fellow and the Board. The agreed area of research will also be determined by negotiation but the Board is prepared to consider any proposal relevant to its interests.

QUALIFICATIONS: The applicants should have a Ph.D degree or its equivalent and be preferably under 30 years of age. Radio Research Board Fellowships are available to applicants of all nationalities but they are asked to indicate their future plans.

STIPEND: The stipend will normally follow that applicable to the Queen Elizabeth II awards, currently $Aust 25,447 (Aust 27,628 over 28 years of age.) The stipend is subject to income tax.

ALLOWANCES: Appropriate allowances and travel expenses are available. Host institutions may be paid an allowance towards the cost of supporting the Fellow.

APPLICATIONS: Persons interested in applying for the above Fellowship should obtain application forms and a statement of the conditions from the Secretary, Radio Research Board, P.O. Box 225, Dickson ACT 2602, Australia.

Applications close on 14 September 1984 and in the normal course of events may be expected to be advised on the outcome of their applications in December 1984.
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