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

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1st Australian Conference on Archaeometry

The Conference is being supported by and will be held at the Australian Museum, College Street, Sydney, 15-18 February 1982.

The purpose of the Conference is to bring together people from diverse fields in the social, natural and physical sciences and the arts, in order to promote interdisciplinary discussions around the theme of archaeometry. Although archaeology and its related studies has been influenced and greatly assisted by developments in other analytical fields, there has been no general forum for communicating the wide range of possibilities that exist for the application of advanced techniques to a broad range of problems in archaeology and museum studies. The aim of this Conference will be to decrease the distance between the relevant fields and to consider the development and application of topics such as:

- Thermoluminescence dating
- Geoarchaeological techniques
- Carbon-14 variations
- Stable isotope techniques
- Accelerator-based dating
- Palaeoecology
- Materials analysis
- Statistical algorithms

We have so far received approximately 120 replies to our Preliminary Notice and more than 60 papers and reviews have been offered. It is intended that the Conference Proceedings will be published in conjunction with the Department of Prehistory, Australian National University.

The statements made and the opinions expressed in The Australian Physicist do not necessarily reflect the views of the Australian Institute of Physics, its Council or Committee.
President's Column

Some of you may have read the Guest Comment in the March 1981 issue of "Physics Today" in which Lewis Branscomb, chairman of the US National Science Board and Chief Scientist of IBM, wrote of his problems in distinguishing between "basic" and "applied" research in Physics. He put the view that such a distinction is futile and, if made at all by working Physicists, is done on grounds of institutional politics or government funding policy rather than on any real characteristic of the research being done.

This view seems to me to be a very reasonable one though I think that many of us probably find the labels "basic" and "applied" to be quite useful in describing the ways in which we talk about our research at conferences and in publications. Our own Institute will hold its next Applied Physics conference in Melbourne in December and I expect the papers will nearly all exhibit a flavour rather different from that of typical papers at our National Congress. Motivation of the research may well have been "pure" curiosity in both cases and the intellectual level of the work is probably, on average, no different. In an applied physics meeting, however, the speakers will usually go out of their way to show how their results can be applied to solve or at least understand some recognisable practical problem. As Branscomb points out, most of us do this when writing our ARGC applications anyway — it is probably an even better exercise for us to do the same thing when the research itself has been finished!

Returning to Branscomb's thesis, it is probably not possible to distinguish even a category called "applicable" research until after the event. Even labels like "mission oriented" research tend to say more about the way in which funds are granted and results reported than about the research itself.

Perhaps we should all be a little more aware of this in the hard times that seem sure to come. Without being dishonest or making exaggerated claims — for, depend upon it, the bluff is sure to be called — we should make the public aware of what basic science in general and physics in particular has contributed to advances in other areas such as medicine and communications. Such informed comment can only help us all in the long run.

Sincerely,

JIM GRAHAM

Editorial

I have an interesting collection of mail that can never find its way in any detail into Aust. Phys. For example there is a copy of the July issue of Bicentenary '88, the newsletter of the Australian Bicentennial Authority. Would there be some activity or display that the physics community can contribute? (See article on history of science project in Physics Roundabout.) There are copies of Physics Today and the IOP Physics Bulletin, packed full of news and opinion concerning physics in Britain and USA. The July issue of Europhysics News is devoted to history and applications of the laser, to commemorate the twenty-first anniversary of the first visible light (ruby) laser. The March issue of the UNESCO Courier is devoted to science in the service of art — authenticity, dating, preservation, and the re-creation of ancient techniques, trade routes and other historical details. Closer to home are the ANZAAS Search the RACI Chemistry in Australia and the IEA Engineers Australia, which often have relevant and meaty articles. I take the view that we should cover direct contributions first, Australian news and notes second, and other items except the most important take pot luck. I see two dangers in this approach; we can become very ingred unless there is a constant supply of review articles on all aspects of physics; and the coverage within Australia can become biased towards those organizations with the most developed publicity arrangements. If you see such a bias developing, please remedy it with a news item, article or review of your own. Many thanks to those who have already contributed.

JIM GRAHAM

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Letters

Dear Sir,

Your 'Editorial' (Aust. Phys. 18, No. 6) prompts me to add my bit. You say "but surely it is inexorable for an attack on science to be broadcast by someone who admits ignorance of the subject and uses as a basis for the attack a philosophical argument advanced without proof". Quite so, and yet this is precisely what happens far too often in the general area of the history and philosophy of science (H.P.S.).

HPS is, and deserves to be, an essential and fascinating branch of learning, and exposure to it should be mandatory for all science undergraduates. Yet, how many working scientists have very much to do with it? I venture to suggest that an important reason for this is not (as has been unkindly suggested) that most scientists are not bright enough to pursue the subject, but that they are put off by the cascade effect of generations of practitioners of HPS quoting each other and submitting theses based on each other's writings. At times, the relationship can only be described as incestuous! But let me — without falling into the trap myself — illustrate the point by referring to a story told during the sitting of the Lamontagne Committee in Canada in the early seventies (when their Ministry of State for Science and Technology was established), of a Canadian student who was so interested in camels that his studies, at a considerable distance from the nearest member of the species, won him a Ph.D. He subsequently obtained a position at a Canadian University where, in the manner familiar to all of us, some of his students emulated him and, in turn, obtained their doctorates by submitting these on the camel, thus creating a self-perpetuating enclaves of "expertise" in the subject in the cold climes of Canada, all without ever having clapped eyes on that curious brown animal.

 Seriously though, what is the solution? As you say, many more scientists should take an interest in writing (and speaking?) for the media. In these times of greater accountability, it would surely be a thoroughly good thing for more scientists to be able to explain their work to funding bodies, politicians, etc. By the same token, journalists should allow the scientists to check any story that has been "popularized" to avoid the inaccuracies that tend otherwise to arise. We all know of colleagues to whom this courtesy has not been extended and who have, as a consequence, avoided, like the plague, any further contact with the media, resulting in a disservice to all concerned.

Yours Faithfully,

G. FISHER

Dear Sir,

Australian Standard: Safety in Laboratories.

Members of the Institute of Physics may recall that over 1979 and 1980 the Standards Association of Australia produced a set of standards with the general title “Safety in Laboratories”. The set comprised AS2243 part 1 (General), part 2 (Chemical), part 3 (Micro-biological), part 4 (ionizing radiation), part 5 (Non-ionizing radiation), part 6 (Mechanical aspects) and part 7 (Electrical aspects). The completion of these standards was followed by a series of meetings in the various States to provide a forum for publicity and discussion.

It has now been decided to review that set of standards to determine whether any revision is required as a result of experience gained. As chairman of one of the committees (part 5) I have undertaken to invite the physics fraternity to provide some input or comment. Copies of the standards are all available from the various offices of the Standards Association of Australia and are probably also, or should be, on the shelves of most libraries in scientific or teaching institutions.

Any comments, criticisms or even ideas for additional, related, standards should be sent to the Secretary.

Mr. D. Allshorn
Executive Officer, Committee CH/26
Standards Association of Australia
Clunies Ross House
191 Royal Parade
Parkville, Vic. 3052
preferably before 30 September 1981.

These standards fill a most important role in ensuring safe laboratory practice and, as such, are evolving and changing documents. Clearly some modifications will be needed as a result of changes to other standards, international standards or items of legislation, but other changes arise from experience being passed on and it is hoped that as many people as possible will take the trouble and time to provide constructive comment.

Yours faithfully,

A.W. FLEISCHMANN
Officer in Charge
Radiation Branch.

Computer Abuse Research Bureau

CIT-CARB, the Computer Abuse Research Bureau, was formed in 1978 by a group of academics and businessmen associated with the Caulfield Institute of Technology to monitor computer abuse within Australia and inform the business community of their findings.

Computer Abuse has been defined by the Bureau as losses, theft, fraud, embezzlement or damage resulting from negligence or deliberate actions relating to computer systems and includes:

(i) inadequate or improper management planning and control;
(ii) unauthorised or improper use or manipulation of computer input, processing, or output;
(iii) trespass on a data processing installation, theft of equipment, input, files, or output;
(iv) sabotage of computer installation equipment; or
(v) any other computer security violation.

The Bureau sponsors research projects, and runs annual Seminars. The Secretary can be contacted by P.O. Box 197 Caulfield East Vic. 3145.
1. INTRODUCTION

Macquarie University has offered courses leading to the BA degree, with majors in physics and physics/electronics since 1967; a Graduate Diploma in Electronics was inaugurated in 1972 and a BSc degree has been offered since 1981. Individual staff members in these areas frequently extend to their students the verbal carrot of good employment opportunities in interesting fields. Although sincerely held, this belief rests more on casual knowledge of a few cases histories than on a comprehensive study. Accordingly, it was decided to survey Macquarie’s physics/electronics graduates for details of their job-seeking experiences. This survey supplements several surveys of employment opportunities for physicists which have been published in recent issues of the Australian Physicist — see for example Prescott’s, and references therein.

2. RESPONSES TO SURVEY

The survey was defined as those who had completed the 300-level course “Electromagnetism” between 1969 and 1980. This course is mandatory for all serious physics and electronics students. Unfortunately we could only find (supposedly) current addresses for 80% of this population. Of the 88 questionnaires sent out on 21 April 1981 a total of 61 had been returned by 30th June 1981. Of the 61 respondents, 52 had BA’s and 9 had BSc’s; about 50% of respondents had completed their Honours year, and/or Diplomas in Education or Electronics as well. Seven respondents had taken higher degrees. Major areas of study were distributed among — physics (22), physics-mathematics (12), physics-electronics (14), electronics (1), others (12). The questions and responses were:

Q1. (a) Were you in employment or bonded before completing your degree?
Response: No (31); Yes (30); of these, 18 were bonded to the Education Department.
If Yes, (b) was University training in physics or electronics necessary or highly desirable?
Response: Physics: necessary (11) highly desirable (16); Electronics: necessary (5) highly desirable (8).
(c) Did you change your job as a result of completing your degree?
Response: No (20); Yes (7).

Q2. If you were not in employment or bonded:
(a) On completion of your studies were you actively seeking employment?
Response: Yes (22); No (8).
If Yes, (b) How long did it take you to find a job?
Response: Range 0-6 months, Mean 2 months, Standard deviation 2 months.

(ii) Were you reasonably content with your position?
Response: Yes (15), No (6).
(iii) Was University training in physics or electronics essential or desirable for this job?
Response: Physics: essential (6), desirable (10); Electronics: essential (4), desirable (5).

Q3. In retrospect, (a) taking into account the access to employment, salary, job satisfaction and other considerations, do you feel your decision to take a major part of your studies in physics or related areas was a wise one?
Response: Yes (52), No (4).
(b) If you had the opportunity to begin your University studies all over again, in what areas would you choose to major?
Response: (i) No essential change (34),
(ii) 29 respondents indicated changes as follows: include more computing (7); include more maths (6); include more electronics (6); pursue an engineering course (5); others (5).

Q4. Respondents were invited to comment briefly on anything they considered relevant; 31 chose to do so. Some comments are paraphrased below:
“Physics is highly desirable, more should do it.” (a chemist).
“Physics is more important than geology for geophysicists” (a geophysicist).
“I appreciate a physics background for its approach to problem solving. My medical colleagues labour at a disadvantage”. (a scientist involved with the physical biochemistry of proteins).
“There is a dearth of teachers trained to teach physics. Training in this area is an advantage once employment has been obtained”. (5 respondents commented along these lines).
“I studied physics for reasons of job satisfaction. Although salaries are not bad, access to employment has been disappointing”.
“Man does not live by bread alone”.
“Maths without physics is too isolated”.
“I doubt that I will ever be employed in physics as I’m neither bright enough nor sufficiently dedicated, but it has taught me many useful skills as well as being a great deal of fun and a challenge”. (similar comments were made, less eloquently, by 4 others). Two respondents complained of handicaps suffered as a result of the BA label and the lack of a retrospective BA → BSc conversion.
Two respondents expressed frustration at not being admitted to the I.E. Aust.
Several respondents praised the quality of education received at Macquarie.

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3. CONCLUSIONS

The principal findings of this survey are as follows:
(a) Approximately half the sample were either in employment or bonded to an employer before completing their degrees. This proportion will be radically altered by recent changes in Education Department policy.
(b) About one third of the sample were actively seeking employment on completing their degrees. Some had immediate success, others took up to 6 months to find a job; the mean as 2 months. Subjectively it seems that the quality of a graduate's academic record and his/her personality is an important factor.
(c) About ¾ of new employees were satisfied with their position.
(d) There was overwhelming satisfaction expressed concerning the choice of physics as a major area of study.

4. REFERENCES


FROM MOLIERE TO MARX — A PHYSICIST'S CAREER?

It was in the mid-1960s that I began, with a newly formed interdisciplinary group of scientists, to teach materials science at Sussex University. Being the first degree course of its kind in the country, one of the many problems that faced us was the matter of professional development of our students after graduation. At that time, the Institution of Metallurgists was an inward-looking, rather reactionary body, whereas The Institute of Physics was apparently making deliberate efforts to encompass materials-oriented science within its range of interests. In particular, the Materials and Testing Group was organising important meetings and conferences and we had no hesitation in those days in directing our new graduates towards membership of The Institute of Physics.

The Materials and Testing Group has always had a special interest in composite materials, which also happens to be my own research field, and I found myself helping to organise conferences for the Institute and being co-opted to membership of the materials and Testing Group, despite not being a member of The Institute of Physics. I did subsequently apply for Membership, but was instead elected to Fellowship, despite my training as an industrial metallurgist, my industrial periods in metallurgical research, and my current (contemporary) research interest in reinforced plastics. I therefore began to believe, like Moliere's prose-speaking Bourgeois Gentilhomme, that I had in reality been doing physics all the time! With limitless audacity I published papers in J. Phys. D: Appl. Phys., which had, by then become an appropriate journal for the works of engineers, chemists and materials scientists, as well as those of us physicists. I have since even become a regular referee for the Institute's publishing arm, an activity which I have enjoyed and from which I have benefited enormously.

Now, however, the masquerade is over. For two years or so I have been trying to obtain the Institute's recognition that the honours degree course in materials science taught at the University of Bath contains sufficient 'physics' for our graduates to offer it in part qualification for membership. Council has just refused this recognition, the problem being, I suspect, that the physics is integrated with the engineering and the chemistry of materials, and a phase separation exercise of the kind that Council requires is simply not possible.

I have no wish to question Council's decision but I am constrained to point out that I am, as a consequence, no better qualified for membership of the Institute than any one of our honours graduates. I must therefore formally resign my Fellowship and, like Groucho, also resign myself to the fact that there is apparently no virtue in belonging to an organisation that would accept me as a member. Sic transit . . . . !

Luckily, during the last 15 years the Institution of Metallurgists has accepted its role of professional body for materials scientists, and we shall be working too hard to achieve recognition of our course by the CEI for C Eng status to worry about qualifying for Institute membership. I wonder, though, whether the Institute knows what it is doing. Does it really wish to exclude from membership all who do not have an easily recognisable 'physics' component in their training, regardless of what work they do? Does it wish to suggest that Groups like the Materials and Testing Group, the Carbon and Graphite Group or the newly-formed Tribology Group should either not exist or should limit their activities to something which is arbitrarily defined as 'physics'? Does it propose to scrutinise papers submitted to J. Phys. D more closely than hitherto for genuine 'physics' content? Will it discontinue the practice of using non-'physicists' as referees for its journals? Will it exclude from future editions of Research Fields in Physics all entries deemed not to be proper 'physics'?

Having just read the article 'Moving closer to the engineers' in the current Physics Bulletin (April 1981 p109) I feel that I can afford a smile, and a gesture of good luck to the Institute from a former physicist!

Bryan Harris
Professor of Materials Science, University of Bath.

A letter to make us think. Reprinted from Physics Bulletin
RECENT LASER DEVELOPMENTS

A report on LASERS '80 — the International Conference on Lasers held in New Orleans, U.S.A., December 1980

F.J. Duarte and M. Brandt, School of Mathematics and Physics, Macquarie University, NORTH RYDE N.S.W. 2113

INTRODUCTION

LASERS '80 was the third in a series of annual conferences which is held in the U.S.A. during December.

The LASERS conference usually lasts five days and is sponsored by the Society for Optical and Quantum Electronics in cooperation with the American National Science Foundation and Army Research Office. The intent of the LASERS conference is to create a single forum for exchanging information related to lasers, extending from the fundamental aspects of laser operation to the variety of laser applications. Invited papers, contributed papers and panel discussions are the means for bringing about this information exchange. The full length papers are published in a volume of proceedings.

The LASERS conference has grown considerably in both size and importance since its inception in 1978. The program of LASERS '80 necessitated four parallel sessions on each day of the conference. Similarly, conference attendance has increased considerably since the first meeting in Orlando in 1978. The LASERS '80 conference attracted speakers from U.S.A. and Japan, as well as from Europe, Russia, China and Australia.

The keynote address at LASERS '80 was delivered by the father of the laser, Dr. Theodore H. Maiman. In his address Dr. Maiman talked about the events leading to the discovery of the ruby laser and the impact lasers are making in today's society. He concluded with the remark that the laser is no longer a "solution looking for a problem" and that the next several decades will see not only development of more new laser systems, but also a substantial increase in the use of lasers in everyday life.

In the present report we direct our attention to the major sessions of the conference and some individual research topics which were particularly interesting.

MERCURY HALIDE LASERS

Mercury halide lasers were the subject of two entire sessions of the conference. The importance of mercury halide lasers stems from their potential to generate relatively high-power, high-energy pulses in the 500 nm region of the spectrum. These lasers thus represent the most promising candidates for laser underwater communication and remote sensing.

In the three years since such lasers were first operated at the Naval Ocean Systems Centre, San Diego, U.S.A., significant progress has been made towards achieving high-power, high-energy pulse requirements. E.J. Schimitschek of Naval Ocean Systems Centre described the most recent experiments investigating both the volumetric and repetition-rate scaling of a UV pre-ionized, discharge-pumped mercury bromide laser. The scaling experiments were performed employing a laser tube of diameter 15 cm and length 152 cm with the active volume of 720 cm³. With this device Dr. Schimitschek obtained output pulse energies greater than 300 mJ per pulse at a repetition rate of a few Hz. Such high pulse energies were the highest reported for mercury halide lasers.

For high repetition-rate experiments Dr. Schimitschek employed a mercury bromide laser of active volume about 60 cm³. This device yielded 30 mJ per pulse for input energy of 5 J and was operated up to 200 Hz. Dr. Schimitschek reported that time and amplitude jitter were very low and that after three hours of operation at 30 Hz laser output dropped by only 35%.

J. Hsia and J. Jacob of Avco Everett Research Laboratories described operation of E-beam controlled mercury chloride and bromide lasers. They reported peak powers of 220 kW in laser pulses of duration 150 ns (full width half maximum). In a similar attack on the problem, W.T. Whitney and R. Burnham of Naval Research Laboratories extracted 100 mJ per pulse from an active volume of about 100 cm³. The characteristics of the E-beam employed by Whitney and Burnham were: current density 0.3 A/cm², voltage 150 kV and pulse duration 400 ns.

One of the problems associated with mercury halide lasers is the relatively short lifetime of laser tubes attributed to the corrosive nature of the reactants in the volume. Bob Liu of Westinghouse Research and Development Centre, Pittsburg, presented a paper on the materials for electrodes and discharge tubes for discharge excited mercury halide lasers. Dr. Liu carried out experimental investigations of the reactions between electrode materials, (such as nickel, vanadium, gold, stainless steel and others) and corrosive HgBr, vapour under laser discharge conditions. His results suggest that for the range of materials tested the most suitable material for electrodes was gold. Of course Dr. Liu was quick to point out the impracticabilities of manufacturing electrodes from gold and remarked that from an economic point of view, as well as from his experiments, stainless steel 316 would give reasonable tube lifetimes, in excess of several hundred hours.

MATERIAL EFFECTS AND APPLICATIONS

Several authors discussed laser induced breakdown on liquids and glass surfaces. At the same time techniques and improved methods to treat glass materials against laser damage were presented. M.J. Soileau of North Texas State Univ. and J.B. Franek of Naval Weapons Center gave experimental details on laser induced breakdown in liquids with a high Kerr constant (non-linear index). In their experiments, they irradiated samples of liquids with a pulsed Nd-YAG laser and concluded that the laser power required for breakdown on liquid is inversely

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proportional to the Kerr constant. In a further experiment P.A. Temple and M.J. Soliean investigated laser induced breakdown on fused SiO₂ and graded-index glass surfaces. Laser damage threshold powers for surfaces polished using different techniques were presented. The SiO₂ subjected to study was super-polished, laser polished and fractured amorphous SiO₂. It was concluded that laser polished, fractured, and chemically etched surfaces have substantially higher damage thresholds than lap-polished surfaces.

Results of annealing experiments on damaged silicon solar cells, with a high repetition rate copper halide laser (average power 15W) were presented by T.J. Pivrotto of Jet Propulsion Laboratory. Preliminary results have indicated that the amount of damage, caused by a simulated space radiation environment, can be reduced as much as 41%.

**OPTICAL ABSORPTION DEPTH VS WAVELENGTH FOR PURE SILICON AND GERMANIUM AT ROOM TEMPERATURE**

![Figure 1](image1.png)

**FIGURE 1** — Optical absorption depth as a function of wavelength for Si and Ge. All figures are from J.P.L. publications, with permission.

**SCHEMATIC OF SOLAR CELL ANNEALING EXPERIMENT**

![Figure 2](image2.png)

**FIGURE 2** — Experimental arrangement for Laser Annealing of Si solar cells.

**EFFECT OF ANNEALING RADIATION DAMAGED SILICON SOLAR CELLS WITH A COPPER HALIDE LASER**

![Figure 3](image3.png)

**FIGURE 3** — Post laser annealing effect on Si solar cells.

Given the output emission characteristics of a high repetition rate copper halide laser it was found that this laser system compared very favourably with lasers such as argon ion, ruby and YAG in annealing silicon and germanium. Figure 1 compares optical absorption depth (µm) as a function of wavelength for Si and Ge at room temperature for different laser systems.

The experimental set up used by T.J. Pivrotto is shown in Figure 2. The cell is kept in a vacuum chamber and can be moved on the x – y plane whilst the laser spot diameter is adjusted. The radiation energy density on the damaged silicon solar cells was of the order of 500 J/m². A typical result comparing pre- and post-laser annealing in silicon solar cells, using a Cu-Halide laser, is shown in Figure 3. The effect of laser radiation on the silicon cells seems to be enhanced by higher peak powers rather than higher average power. Although the experimental results presented by T.J. Pivrotto were of a preliminary nature, they were judged to represent a step backward in laser annealing.

At the post deadline session, M.A. Kazaryan, G.G. Petrash and K.I. Zemskov from Lebedev Inst. of Physics USSR, discussed experiments involving optical systems with brightness amplification. Brightness amplification is conceptually possible in systems involving high pumping rates in large volumes. Experimental results on laser projection systems using several metal vapour amplifiers were presented. High resolution amplified images of micro objects (biological samples and solid state microcircuitry) were obtained in the U.V. visible and I.R. spectral regions. The laser systems involved in the investigation were copper, copper chloride, gold, barium, lead and manganese. All amplifiers operated in the range of significant saturation of the active volume. Gain factors in the range 10⁶ to 10⁹, which depend on input power, made it possible to obtain images of micro-objects on large screens with high linear magnifications. Employing a CuCl laser, 2.5 W average power, images of micro-objects of up to 25 m² were obtained. By far the most suitable “laser microscope was the CuCl system, λ = 5106Å.
EXCIMER LASERS

Excimer lasers utilize short lived excited molecules such as KrF* which, when dissociating emit energy in the form of light. A typical excitation-emission cycle in a discharge laser is

\[ e + Kr \rightarrow Kr^* + e; \quad Kr^* + F \rightarrow KrF^* + F \]
\[ KrF^* \rightarrow Kr + F + h \]

In the excimer laser research effort, the emphasis seems to be concentrated on obtaining higher powers and high repetition rates. This search has been, to a certain degree, triggered by the likely use of high power excimer lasers in fusion experiments. On the other hand, compact reliable high repetition devices for a number of applications (photochemistry, spectroscopy, dye lasers) are being sought with increasing interest.

In the first area of excimer laser research, characterization of X-ray pre-ionized excimer laser discharges is quite important. **(X-ray pre-ionization has been found to be superior to conventional pre-ionization techniques)**. N. Djeu of Naval Research Laboratories discussed X-ray pre-ionization characteristics of a XeCl excimer laser. Emphasis was given to comparison between predicted and measured current voltage characteristics during the pre-ionization process. Experimentally, the laser was successfully operated in an injection locking arrangement. S. Sumida of Keio University - Japan, discussed pre-ionization requirements for a high power discharge KrF laser. The authors concentrated their studies on the effects of the pre-ionization electron number density and its distribution. Their X-ray pre-ionization KrF laser yielded output pulses of 2 joules. Unfortunately, perhaps one of the most promising papers in this session with withdrawn; the paper was to have reported a high average power rare gas halide vapour laser operating at 1 kHz with an average output power of 100 W.

The highlight of the excimer laser session was a paper by R.C. Sze and E. Seegmiller of Los Alamos on high repetition rate, miniature KrF and XeCl lasers. At 1 kHz the energy per pulse was 1 mJ for the KrF and 0.5 mJ for the XeCl system. The net gain in the XeCl laser was determined to be 0.3 cm\(^{-1}\) and the overall efficiency was as high as 0.25% per cent.

This small laser device, 10 cm active length, with a variable output pulse width was built to perform injection locking on a large volume laser. Sze said that only 100W/cm\(^2\) are needed to successfully injection lock a laser amplifier of nearly 0.5 J output.

LASERS FOR FUSION RESEARCH

Probably, the most interesting aspect in laser fusion research is the focus placed on new laser systems such as iodine lasers, V\(^{2+}\) : MgF, solid state lasers, free electron lasers, and excimer lasers (KrF).

Although the interest in high power CO\(_2\) lasers still remains, the amount of research on Nd glass systems appears to have diminished considerably.

An advanced optical multiplexing concept for a fusion CO\(_2\) driver was discussed by F.B. Munola of Perkin-Elmer. The author studied the feasibility of a megajoule CO\(_2\) laser incorporating a multiplex train pulse generator and power amplifier module scaling. It was concluded that modules with energy output approaching 200 kilojoules and efficiencies exceeding 10% are possible.

E.V. George of Lawrence Livermore Laboratory presented a paper on the scaling properties of an E-beam pumped KrF laser. Also the possibility of using several other laser systems for laser fusion was discussed. Of the various systems, KrF (\(\lambda = 249\) nm) promises an efficiency in the range 5 - 8% and the cost per joule is about $300. The major disadvantage of the KrF system is the complexity and cost of the U.V. optics. A Hybrid KrF/CH\(_4\) system offers an efficiency of about 4 - 5% at a wavelength of 268 nm. Again the cost is nearly $300 / J.

The compression of KrF laser pulses, using CH\(_4\) gas, is based on a principle of backward stimulated Raman scattering. The long KrF laser pulses (100 ns) enter a 15 m long CH\(_4\) Raman cell which is being longitudinally pumped by an externally generated 268 nm Stokes pulse. As the Stokes pulse travels through the KrF pulse it extracts energy from the longer pulse, producing a much shorter pulse at a longer wavelength. Thus the 249 nm KrF pulse compressed in CH\(_4\), results in a 268 nm backward Stokes pulse with a 10 - 15 ns duration at a conversion efficiency of 50%. Better spatial coherence from the resulting shorter pulse is also expected.

A free electron laser (F.E.L.) offers a potential efficiency of nearly 15% and a cost per joule of $150. The main problems associated with a F.E.L. are pump propagation losses and accelerator technology. E.W. George estimates that a successful laser system would have to be less than 200 p J joule.

W.F. Krupke, also of Lawrence Livermore Laboratory discussed the conceptual design of an efficient (\(>5\%\) high average power (10 MW) solid state laser for fusion applications. Krupke studied a flash lamp pumped V\(^{2+}\) : MgF, (doped magnesium fluoride) solid state gain medium. The output energy of such a system would be \(~3\) MJ in a 5 - 20 ns pulse at a peak power of \(-200\) TW. This laser would compare favourably with the Nd:YAG systems, since the efficiency in the latter is about 3.5% and thermal loading characteristics pose a serious problem which limits its repetition rate. Ultimately the V\(^{2+}\) : MgF system would offer a repetition rate of 5 Hz, at \(\lambda = 1120\) nm, and an efficiency approaching 10%. Optical pumping will be carried out using Xenon flash lamps and the laser will be cooled using an axial gradient gas flowing system. Superior efficiency and thermal conductivity over the Nd:YAG laser, and a cost of about $100 per joule make the V\(^{2+}\) : MgF, solid state system an attractive laser fusion candidate.

J.C. Guyot and & J. Parey of Labs de Marcoussis France, and S. Witkowsky of Max Planck Gesellschaft W. Germany, discussed in two separate papers, the iodine laser as a fusion tool.

The major advantages of an iodine laser include the avoidance of cycling limitations and low efficiency present in neodymium-glass lasers. The output emission wavelength, 1.3 \(\mu\)m, is short enough to drive fusion reactions. This latter factor is an advantage when comparing the system with the 10.6 \(\mu\)m output of a CO\(_2\) laser.

The overall efficiency of an Iodine laser is limited by the energy needed to produce a large yield of atomic iodine from the donor molecule (usually C,F,I). The French group reported the use of flash lamps directly placed inside the active medium. The efficiency of an Iodine system can be expected to be in the range 5 - 10%.

ACKNOWLEDGEMENTS

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The Australian Physicist, Vol 18, September 1981 — Page 155
Electrostatically Screened Current Transformers in Measuring Circuits

P.J. Betts, CSIRO, Division of Applied Physics, Sydney, Australia, 2070

SUMMARY
Where the errors of a current transformer are appreciably dependent upon dielectric leakage effects, the versatility of the transformer in measuring circuits can be greatly increased by separately enclosing both the primary and secondary windings in electrostatic screens. It is shown that this versatility stems from the fact that the existence of a voltage between primary and secondary windings does not contribute to the errors, providing certain rules are complied with in the way in which the screens are connected in the circuit.

1. INTRODUCTION

One of the factors which causes a Current Transformer (CT) to introduce errors into the measurement of current is the presence of leakage currents in the windings. These CT errors* have been analyzed by Arnold (1950) in terms of equivalent lumped dielectric admittance values without reference to the influence of sources external to the CT. Kusters (1962) has taken the analysis further to include capacitance leakage currents between the CT and earth. He has shown that by enclosing both windings in electrostatic screens, the windings can be electrostatically isolated from each other and from external voltage sources. Hence electrostatic screening is particularly advantageous where high voltages exist between the primary and secondary windings or where the CT is particularly susceptible to dielectric leakage effects. In such cases the CT may be calibrated with both its windings at earth potential and then used with any voltage existing between its primary and secondary windings without additional error.

Although reference to the advantages of electrostatically screened CTs has been made before, very little attention has been given to the practical aspects of their use. It is the purpose of this paper to describe the ways in which these CTs are constructed and the precautions that need to be taken in the way in which the screens are connected.

2. TYPICAL CONSTRUCTION OF A SCREENED CT

Normally a separate electrostatic screen is provided for both the primary and secondary windings, although a CT used for low accuracy current measurements in a high voltage transmission line may only have a secondary winding screen.

The secondary winding will normally be applied closest to the core. Under these conditions the screen will be applied outside the winding and will totally enclose it. In order to totally enclose the primary winding, it must have a screen applied on its outside and inside. However, an inner primary screen alone is sufficient for all but the most stringent requirements of accuracy.

All screens are insulated from the winding which they screen and from each other and the inner and outer primary screens are connected together. Separate leads connected to each screen are brought out to terminals on the case of the CT. The screens themselves are made from metal foil and are applied in such a way that they do not form a short circuited turn around the core. (Figure 1.)

3. LEAKAGE ADMITTANCE EFFECTS IN CIRCUITS INVOLVING SCREENED CTs

In order not to introduce unknown systematic errors into a measurement, it is necessary to consider the effects of the leakage admittances in the circuit in which an electrostatically screened CT might be connected. For the purpose of this article a screened CT may be illustrated by the circuit shown in Figure 2.

3.1 Screen connections

Where the CT windings are symmetrically distributed around the core, i.e. \( Y_2 = Y_3 \) and \( Y_5 = Y_6 \) (Figure 2), the errors of the CT will be independent of the end of the winding to which each screen is connected. It is desirable that at least one of the windings of an electrostatically screened CT has symmetrically distributed leakage admittances or much

* For the purposes of this paper, error is defined as the amount by which the secondary current differs from its nominal value, expressed in complex terms as a fraction of the nominal secondary current.

Figure 1. Section through the core of a screened current transformer.

Figure 2. Equivalent circuit of a current transformer with primary and secondary electrostatic screens.
of the versatility of the CT will be lost. Secondary windings of 5 amperes rating are practically always wound in a single uniform layer or several uniform layers connected in parallel and as such it should be possible to connect the secondary screen to either secondary terminal without the errors changing by more than a few parts in ten million (see typical data given in section 5).

Where a multi-ratio CT has a tapped primary winding with one common terminal, Y2 will not equal Y3 (Figure 2). Therefore, changing the primary screen connection from P1 to P2 will cause a different effective admittance to shunt the winding and may cause the errors to change by several parts in one hundred thousand if the current rating is less than about 1 ampere at 50 Hz (see section 5). It will be assumed throughout the remainder of this article that calibration of these CTs is such that the primary screen is connected to one specified primary terminal, but the secondary screen may be connected to either secondary terminal.

3.2 Admittance between screens

The admittance between the screens is likely to be of the order of one microsiemen at 50 Hz and it is therefore important that the circuit is such that this admittance never appears as a shunt across any circuit component which is of primary significance to the measurement. Similarly, it is important that the leakage current which may flow between the two screens is never permitted to flow to earth through any leads or components in a detector circuit.

3.3 Admittance associated with supply and detector

Possible errors due to the shunting effect of the admittance between either side of an electronic detector and earth, or the effective lumped admittance between either supply terminal and earth can be eliminated by earthing one side of the detector and one side of the supply.

3.4 Admittance associated with primary connecting leads

The leakage admittance from the common lead joining the primary windings of two CTs (figures 3 to 5) and another object at a different potential is not likely to cause significant errors providing the primary current rating is above about 5 amperes. Even down to 0.5 ampere rating, the effects are unlikely to be significant if the precaution is taken of well separating the common lead from all other leads and earthed objects. However, at current ratings down to 0.05 ampere, errors at 50 Hz of several parts per million (see section 5) are likely to occur even when this lead is separated from others by half a metre or more. It is possible to correct for the variable effect of this leakage by making the common lead a permanent connection to the screened CT and to extend the primary screen to enclose the lead coaxially.

4. CIRCUIT APPLICATIONS

The following diagrams illustrate a number of circuits in which electrostatically screened CTs may be used with advantage. The particular connections chosen are those which eliminate the errors caused by the leakage admittance effects described above.

Figure 3 illustrates the connections used where one CT is calibrated with reference to another in a differential circuit, Arnold (1934). Figure 3(a) shows the case where only the standard CT is screened; and in Figure 3(b) only the unknown CT is screened; and in Figure 3(c) both are screened. In all cases one side of the supply is earthed and therefore any leakage currents from the supply transformer will either flow to earth without flowing in either CT or will pass through both primary windings equally. In all cases the detector is earthed and therefore any leakage admittance to earth of the detector will only affect the detector sensitivity. In all cases the admittance between the two screens is either directly across the supply or between two earthed terminals, The measurements made with these three circuits will therefore be free from unknown systematic errors due to dielectric leakage effects.

Figure 4(b) illustrates the connections used where a CT is calibrated with reference to the ratio of two known resistors. The circuit is ideal in as much as one of the supply terminals and one of the detector terminals are earthed and there is no leakage path.
is connected to the primary terminal which is remote from the load so that the inter-screen current does not add to the measured load current. The secondary screen is connected to the earthed secondary terminal so that the inter-screen current does not pass directly through the ammeter.

If it were required to measure the current flowing out of the high voltage supply terminal rather than the load current, it would be necessary to connect the primary screen to P2 instead of P1.

5. EXPERIMENTAL RESULTS

Measurements were made on a number of electrostatically screened CTs to establish the effects upon their errors of the following:
(a) changing the primary and secondary screen connections from one end of their respective windings to the other, and
(b) connecting a capacitance of 80 picofarads across the primary winding; this being equivalent to the capacitance which would be imposed by the insulation of a typical connecting lead.

These measurements were carried out using the circuit shown in Figure 3(c) with the CT under investigation connected in the "Standard CT" position and operated at a working burden of 0.2 ohm. A similar CT was connected in the "Unknown CT" position and this was operated at a burden of 0.02 ohm.

Details of the four CTs follow:
Number 1 CT: Tapped primary winding with one common primary terminal covering the ratios from 5/5 up to 80/5, symmetrical secondary winding with 480 turns, class 0.01.
Number 2 CT: Tapped primary winding with one common primary terminal covering the ratios from 0.5/5 up to 5/5, symmetrical secondary winding with 300 turns, class 0.01.
Number 3 CT: Primary winding in 10 uniform sections which may be connected in series/parallel combinations covering the ratios from 0.05/5 up to 0.5/5, symmetrical secondary winding with 200 turns, class 0.01.
Number 4 CT: Tapped primary winding with one common primary terminal covering the ratios from 0.05/5 up to 0.5/5, symmetrical secondary winding with 80 turns, class 0.2.

The class designation given above is an indication of the errors of the CTs in per cent at their rated burden.

The result of the measurements are given in Table I.

### TABLE 1 - MEASURED CHANGES IN ERROR

<table>
<thead>
<tr>
<th>CT No.</th>
<th>Ratio</th>
<th>$\delta_{ea} \times 10^{-5}$</th>
<th>$\delta_{eb} \times 10^{-5}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Primary Screen</td>
<td>Secondary Screen</td>
</tr>
<tr>
<td>1</td>
<td>5/5</td>
<td>1 — j1</td>
<td>0.0 + j0.1</td>
</tr>
<tr>
<td>2</td>
<td>5/5</td>
<td>4 + j12</td>
<td>0.0 — j0.1</td>
</tr>
<tr>
<td></td>
<td>0.5/5</td>
<td>13 + j47</td>
<td>0.0 + j0.0</td>
</tr>
<tr>
<td>3</td>
<td>0.5/5</td>
<td>1 — j1</td>
<td>0.0 + j0.0</td>
</tr>
<tr>
<td></td>
<td>0.05/5</td>
<td>4 — j14</td>
<td>0.4 — j1.5</td>
</tr>
<tr>
<td>4</td>
<td>0.5/5</td>
<td>100 — j700</td>
<td>0 + j0</td>
</tr>
<tr>
<td></td>
<td>0.05/5</td>
<td>400 — j2700</td>
<td>0 + j0</td>
</tr>
</tbody>
</table>

$\delta_{ea} = \text{Change in error resulting from a change in screen connection from one end of the winding to the other.}$

$\delta_{eb} = \text{Change in error for an increase in shunt capacitance across the primary winding of 80 picofarads.}$

*The Australian Physicist, Vol 18, September 1981 — Page 158*
The results given in Table I show that in all the CTs investigated, the $\Delta R_p$ effect on the secondary winding is negligible. However, where the primary winding is of the tapped type and hence dielectric leakage effects non-uniform throughout the winding, a very considerable $\Delta R_p$ effect is evident. Where the primary current rating is as low as 0.05 ampere and hence the turns ratio high, the shunting effect of 80 picofarads on the combination of the primary winding impedance and the burden impedance reflected into the primary is considerable as shown by $\Delta R_b$.

6. CONCLUSIONS

Electrostatically screened CTs can be used in measuring circuits without the need to make compromises with the effects of various leakage currents. Care should be taken in deciding upon the screen connections and some general rules in this regard are as follows:

(a) if one end of a winding is earthed, the screen associated with that winding should be connected to the earthed terminal,

(b) if there is a connecting link between one primary terminal and one secondary terminal, the screens should be connected to the terminals thus linked,

(c) if the secondary winding is earthed but the primary winding is entirely above earth, the primary screen should be connected to the primary terminal most remote from earth.

The extra complication incurred by the use of screened CTs is only justified where measurements of high accuracy are required, or where the effects of dielectric leakage currents are a major source of error.

The adoption of electrostatic screens will not necessarily reduce the errors which are caused by interwinding leakage currents. In fact such errors will probably be increased under the condition where both windings are at the same potential. However, electrostatic screening will ensure that there will be no change in the errors when the CT is connected into a circuit where the primary and secondary windings are at appreciably different voltages.

REFERENCES


The IUVSTA: Its Organisation and Activities

John L Robins, Australian Representative, IUVSTA Executive Council, Physics Department, University of Western Australia

The International Union for Vacuum Science, Technique and Applications (IUVSTA) was formed over 20 years ago in 1958 and has since developed to its present stage with a membership of 22 countries, with 3 more applications pending. The members of the IUVSTA are national bodies and these are generally the national vacuum societies of the respective countries.

IUVSTA ACTIVITIES

Matters with which the IUVSTA concerns itself are as follows. It acts to achieve the advancement of science through improving communication between national organisations and individuals. It produces the IUVSTA News Bulletin on a quarterly basis. It maintains a list of dates of proposed meetings and conferences in the field to assist organisations in the planning of meetings. It cooperates in work on technical standards and problems of nomenclature. It engages in educational activities and it administers an international scholarship program.

Perhaps the IUVSTA is most widely known for its organisation of the triennial "International Vacuum Congress" since its inception in 1958 and the triennial "International Conference on Solid Surfaces" since 1971. In addition it sponsors other national and international conferences and summer schools in fields related to vacuum, thin films and surfaces. As from 1981 it has also taken on the responsibility of organising the triennial series of International Thin Film Congresses.

IUVSTA ORGANISATION

The organisation within the IUVSTA is as follows. The national bodies which are members of the IUVSTA each nominate a representative for the Executive Council which meets twice per year and manages the affairs of the Union between the triennial General Meetings. On a more continuous basis the administration is carried out through a number of standing committees, namely the Finance, Statutes, Publications, Education, Congress Planning and Welch Scholarship Committees. In addition there is the Scientific and Technical Directorate which, as its name implies, directs all the scientific and technical activities with which the IUVSTA is concerned.

As the scientific scope of the Union has broadened in recent years, this has been accommodated by the creation of separate divisions under the Scientific and Technical Directorate. These are the Surface Science Division, the Thin Film Division and the Vacuum Science Division. In addition, two new divisions are presently being formed, namely the Electronic Materials Division and the Fusion Technology Division.

For each division an electoral college is formed of representatives, one of whom is nominated by each country. This college then elects seven of its members to form the Divisional Committee which may then also elect three further international specialists in their field. However, close contact is maintained with all college members as these are taken to be the national representatives in matters concerning the speciality of the division.

NATIONAL VACUUM SOCIETIES

In most countries the National Vacuum Society has taken on a special role, namely that of being responsible for a wide range of recently developed scientific activities and educational courses under the auspices of the IUVSTA.
and developing areas of research and technology which are highly interdisciplinary. The unifying feature of these is that they either involve the use of vacuum or owe their origins to vacuum research.

The dramatic advances in ultrahigh vacuum technology which occurred about 25 years ago involved extensive studies of gas adsorption on and desorption from surfaces within the vacuum systems. These studies extended to the analysis of surface structures and surface contaminants, all on an atomic scale. From this and the ability to maintain atomically clean surfaces for extended periods of time have come studies involving the interaction of photon, electron, atom and ion beams with surfaces. This in turn has made possible the preparation of thin films and the layered structure of microminiaturised integrated electronic devices. Indeed it is true to say that advances in ultrahigh vacuum technology have spawned a new genre of scientific research and technology.

Clearly these new fields are highly interdisciplinary in their science, technique and applications, and it is understandable that they have grown up with and been fostered by the National Vacuum Societies. The present broad scope of concern of the American Vacuum Society is a prime example. In the same way these fields are more efficiently catered for by coordinating them within the IUVSTA rather than attempting to settle them either within IUPAP or IUPAC where either the physical or chemical interests might tend to predominate.

AUSTRALIAN REPRESENTATION

In the absence of an Australian Vacuum Society, the Vacuum Physics Group of the Australian Institute of Physics was invited to join the IUVSTA in 1971 and is presently the national member of the Union. However the important development whereby the Solid State Division of the Royal Australian Chemical Institute is so actively fostering the field of surface science is fully recognised. Thus in nominating national representatives for the Divisions, the Vacuum Physics Group has always endeavoured to nominate the most appropriate person regardless of his affiliation within Australia.

The present Australian representatives for the 1981-83 triennium are as follows.

- IUVSTA Executive Council: Dr. J.L. Robins
- Surface Science Division: Professor D. Haneman
- Thin Film Division: Dr. R.P. Netterfield
- Vacuum Science Division: Mr. D.L. Swingler
- Electronic Materials Division: To be nominated
- Fusion Technology Division: To be nominated
- Education Committee: Dr. A. Simpson
- Publications Committee: Professor R.J. MacDonald

The IUVSTA is anxious to have Australian participation in the Union's activities. Any suggestions, ideas, inquiries or offers of help or support will be welcomed and may be addressed to the author, Dr. J.L. Robins, or to any of the other representatives mentioned above.

CSIRO RESEARCH TRENDS

CSIRO is to intensify its research into energy conservation, industrial microbiology, water purification, wood-based industry and manufacturing technology, said the Minister for Science and Technology, Mr. David Thomson.

This follows internal changes to the Organization announced to staff by its Chairman, Dr. J. Paul Wild.

First steps involve the re-organization of two Melbourne-based CSIRO Divisions following advice to the Executive from a number of review committees and the Government-appointed CSIRO Advisory Council.

Mr. Thomson said CSIRO had also taken into account views expressed by the International Energy Agency following its examination of energy research in Australia.

"The Division of Mechanical Engineering is to be closed and most of those resources used to form a new Division based in Melbourne devoted to energy conservation research," he said.

"This change took place on 1 September when the formal transfer of about 340 scientists and support staff from the Australian Atomic Energy Research Establishment was planned to occur.

"At the time it is likely CSIRO will proceed with the formation of other new research groupings to expand work on fossil fuels, mining of energy resources, alternative fuels and renewable energy, as well as energy conservation."

Mr. Thomson said other resources from the existing Division of Mechanical Engineering would augment the recently-formed Division of Manufacturing Technology.

As well, a new Division of Cellulose Research would be formed using resources of the present Division of Chemical Technology and wood scientists from the Division of Building Research.

"This new Division, to come into being early in 1982 when the Division of Chemical Technology will be closed down, will concentrate on the use of wood and other natural cellulose — based substances as sources of manufactured products, chemicals and usable energy," he said.

"Work on wood as a structural material will remain with the Division of Building Research."

"Other resources from the existing Division of Chemical Technology will be used to form an Industrial Microbiology Unit to capitalise on emerging research opportunities in this important area of biotechnology."

"This Unit will embrace a water studies group to be formed around CSIRO staff responsible for the SIROFLOC process for water purification."

Mr. Thomson said these changes would take place progressively as key personnel were appointed.

"While no new resources have been made available to CSIRO in these research fields, the new arrangements will provide a sharper focus which Australia needs," he said.

"They are part of strategic planning proposals being developed by CSIRO to allow it to maximise its resources in those areas of high national priority which also show scientific promise."

"There is no doubt that increases in productivity flow from research and development expenditure, and it is vital that industry backs government-funded research and further develops its own capability."

CSIRO News Release
New Professor

The recent premature closure of Australia’s only station for balloon-borne astronomy has severely hampered the work of Australian astrophysicists, according to Professor John Thomas, who took up appointment to the Chair of Physics (RAAF Academy) in Melbourne.

Professor Thomas’ research interest for the past 13 years has involved him in balloon-borne astronomy which allows researchers to get infrared equipment above the water vapour in the atmosphere, and gamma ray equipment to even higher and more suitable levels.

“Our present work with ground-based telescopes and airborne systems involves both the investigation of the dense regions of ionized hydrogen in the vicinity of very hot stars, and an understanding of the infrared structure of our own and other galaxies,” he explained.

“Our ultimate aim is to make astrophysical observations in space; we are utilizing balloon-borne systems as intermediate test and observational platforms in working towards space-based systems. We already have a reservation for two self-contained payloads on the Space Shuttle.”

Before his appointment to the Chair, Professor Thomas was a Reader in Physics and Head of the Department of Physics and Chemistry (RAAF Academy).

Professor Thomas graduated from the University of Adelaide as a Bachelor of Science (Physics and Mathematics) and was awarded the degrees of Doctor of Philosophy from the University of Queensland and Doctor of Science from Melbourne University.

He began his academic career as a demonstrator in Physics at the University of Adelaide. In 1950, he joined the staff of the University of Queensland as a Lecturer in Physics and later became a Senior Lecturer and then Reader. In 1963 he came to Melbourne.

In 1957, Professor Thomas was a Nuffield Foundation Fellow. His work in ionspheric physics and astrophysics led to his handling of the US Air Force contract for ionospheric investigations at the University of Queensland, and to his appointment as Australian delegate to the Solar-Terrestrial Physics Symposium in Belgrade in 1966.

He was Convenor of the Australian sub-committee of the Geophysics Group of the Australian Institute of Physics. His astrophysical work commenced first in the field of gamma ray astronomy and this was followed by the development of ground and airborne infrared systems.

Professor Thomas is a Member of the International Astronomical Union and a Fellow of the Japan Society for the Promotion of Science. Last year he became Convenor of the Australian Infrared Space Astronomy Group.

Univ. of Melb. Staff News

Busy Tour

Professor K.D. Cole left La Trobe on 22 July for a busy schedule in the northern hemisphere.

The first stop is London, Ontario where he will participate as a member of the executive committee of the International Union of Geodesy and Geophysics in its business meetings. After three days he will go on to Abingdon, UK to preside over the business meetings of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) at which plans will be made for the next year’s activities. SCOSTEP is developing global plans on the scale of the well-known International Geophysical Year for the intense study of the region of the earth’s atmosphere from 6-100 km altitude.

From 1-15 August he will preside over the scientific assembly and business meetings of the International Association of Geomagnetism and Aeronomy (IAGA) at Edinburgh, Scotland. The Assembly is the largest in the Association’s history with over 600 participants. The meeting will cover not only the earth’s magnetic field but recent research on the outer atmospheres of the earth and the planets and interplanetary space. A highlight of the assembly will be a special symposium on recent results from the recent spacecraft missions to Saturn. At this meeting Professor Cole will deliver not only a presidential report but also four scientific papers representing research with colleagues at Latrobe University, namely Mr Fred Menk and Mr Ray Morris, and with scientists of the Institute of Physics of the Earth, Moscow. He will also give reports of work he did at the Institute of Space Research, Moscow, where he was a guest in January of this year.

Another of his major responsibilities at the Edinburgh Assembly is to run a workshop on the strengthening of studies of geomagnetism and upper atmosphere physics in the developing countries.

After the IAGA meeting Professor Cole will represent that Association at a meeting of the International Association for Meteorology and Atmospheric Physics in Hamburg.
Professor J.C. Ward

Recipient of the Guthrie Medal and Prize of The Institute of Physics for 1981 is John Clive Ward, at present Chairman of the Physics Department at Macquarie University, NSW, Australia. This annual award recognises a physicist of international reputation, and Professor Ward was cited for his contributions to theoretical physics, particularly in field theory renormalisation, statistical mechanics and in the unification of weak and electromagnetic interactions.

Professor Ward obtained his DPhil at the University of Oxford in 1949, and after a period as professor at the Johns Hopkins University in Baltimore, USA, he was appointed professor of Physics at Macquarie University in 1966. Professor Ward includes among his past interests: particle theory, statistical mechanics, solid state physics, with occasional excursions into industrial electronics, defence research and biology. His most important contributions to physics have included work in field theory renormalisation, in which he developed a highly original method for carrying out the renormalisation of S-matrix elements. This method had the advantage of being free from the problem of overlapping divergences. In addition, the 'Ward identities', which express the gauge invariance of a field theory, have been of central importance.

In the area of statistical mechanics, Ward and Kac extended the elementary Bethe-Peierls combinatorial approach towards the two-dimensional Ising model, which Onsager had solved in a rather special way, and they almost reached the final solution. This was an outstanding performance and proved a major step forward. On the quantum statistics of many-fermion systems, Professor Ward wrote some fundamental papers with E W Montroll and with J M Luttinger.

In joint work with A Salam, he advocated and investigated a gauge-theory approach towards the unification of weak and electromagnetic interactions — this approach proved successful, and was recognised by the award of the Nobel prize for 1979. Ward and Salam were the first to suggest that an elementary field must exist with mass about 80 times that of the proton.

Professor Ward describes his long term obsessions as the real connection between unified theories, spin and general relativity, and also the decay of physics teaching in schools and universities.

Mrs Diana Scott has been appointed as Librarian of the Mathematical and Physical Sciences Branch Library at the University of W.A.

Mrs Scott, who succeeds Mrs Julie Maxam, has been acting as an Assistant Librarian in charge of the Library since August 1979.

She holds an honours degree in Physics from the University of W.A. and completed her professional library qualifications in 1980. She joined the University Library in 1978 after working for several years in Industry.

She is particularly interested in promoting the use of computer based information services in the fields of science and technology.

Dr K.A. Amos has been appointed Reader in the Faculty of Science at Melbourne University.

Dr Amos has achieved distinction in the field of nuclear reaction theory. His work on inelastic nucleon nucleus scattering has allowed large bodies of theoretical data on nuclear structure to be subjected to rigorous experimental test and given rise to new insights into reaction mechanisms.

Dr Amos was awarded the degrees of BSc (Hons) in 1961 and PhD in 1965 by the University of Adelaide. He was appointed a Senior Lecturer in the School of Physics at Melbourne University in 1970.

There's a new manager at the Parkes Radio Telescope, following the resignation in April of Les Fellows. He is David Krumlauf, a former science teacher with an interest in astronomy which formed part of his science degree.

David is an American who is a permanent resident in Australia. He graduated BSc from the University of Michigan and has taught in schools in both the United States and Australia.
Two Chiefs Retire
From Sydney Division

Chiefs of two CSIRO Divisions who between them spent more than 80 years with the Organization, retired last month.

Mr Jack Warner was Chief of the Division of Cloud Physics in Sydney from 1972, while Mr Harry Minnett served as Chief of the Division of Radiophysics from 1978.

Mr Warner joined CSIR in 1940 as an Assistant Research Officer at the Radio-Physics Laboratory, where he participated in engineering development work connected with the application of radar techniques.

He transferred to the Cloud and Rain Physics Group in 1950 and made significant contributions to the cloud physics program, as both a research engineer and physicist.

In 1971, he transferred to the Division of Atmospheric Physics and in July 1972, transferred to the newly formed Division of Cloud Physics, becoming its first Chief later that year.

Mr Minnett achieved a worldwide reputation in the fields of antenna design and radio telescopes. He played a major part in the research phase of the Interplanetary Microwave Landing System project.

As a Research Officer with the Division of Radiophysics, he was involved in radar research from 1940 to 1946 and in radio astronomy and radio navigation from 1947 to 1955.

In 1955, he became the Organization’s representative in London during engineering studies for the Parkes radio telescope.

Mr Minnett was appointed acting Chief of the Division of Radiophysics in 1977, becoming Chief the following year. Both men will continue with their Divisions as research fellows.

S.A. Physicist dies

SA earthquake specialist Dr David John Sutton died in Adelaide in early August. He was 54.

A past dean of the faculty of science at the University of Adelaide, he was one of the State’s best-known physicists.

He had an outstanding career as a student at Adelaide High School and later at the University of Adelaide, where he subsequently began post-graduate work on electron diffusion in gases.

During 31 years at the university he changed his research interest to paleomagnetism and later seismology, which became his major field of interest.

Dr Sutton was responsible for setting up a network of seismic stations throughout SA which provides information about seismic events and contributes data to the world-wide study of earthquakes and earthquake prediction.

There are now 12 stations with a total of 18 seismic recorders in SA — all established as a result of Dr. Sutton’s work.

As a consequence of his work he was a university consultant to insurance companies and on various State and national committees such as the National Committee for Earthquake Engineering.

Dr Sutton is survived by his widow and four children.

Physicist Appointed to Top University Post

The Vice Chancellor of the University of Tasmania, Professor David Caro, has been appointed Vice-Chancellor of Melbourne University.

He is expected to take up his duties on June 1 next year.

He will succeed Professor Sir David Derham, who is resigning as vice-chancellor at the end of May.

Professor Caro was Melbourne University’s first full-time deputy vice-chancellor from 1972 to 1977 before becoming vice-chancellor in Tasmania in January 1978.

He was born in Melbourne in 1922, educated at Geelong Church of England Grammar School and at the universities of Melbourne and Birmingham.

After serving with the RAAF from 1941 to 1946, he graduated as a Master of Science with first-class honors.

He was awarded the Dixon Scholarship in Physics and went to the University of Birmingham where he obtained his doctorate of philosophy.

He returned to the University of Melbourne in 1952 and from 1961 to 1972 was professor of experimental physics and head of the school of physics, also serving as associate dean and dean of the faculty of science.

Professor Caro said that he was taking over at a time when education cuts meant things were not easy for any university, particularly because of the lack of financial compensation for inflation. So it was necessary to sort out priorities and try to retain those, he said.

"I want to keep the place going as it is. You don’t move into the job to create great change, you hope to keep the place moving along," he said.

"Melbourne is a research university. We have got to maintain that, no matter what. The sort of things that are being cut in universities are more the frills round the edges."

"What all vice-chancellors want to do is encourage the academic staff to bring out the best in themselves. We have got to produce that sort of environment."

Professor Caro is also deputy chairman of the Australian Vice-Chancellors’ Committee.

Professor Caro has made important contributions to the advancement of physics, designing one of the first variable energy cyclotrons in the world, and he established the only high-energy physics research group in Australia.

He is a past president of the Australian Institute of Nuclear Science and Engineering. His text, ‘Modern Physics’, is in its third edition. Professor Caro was awarded an OBE in 1977.

Professor Caro is married with two children, a son who is in England and a daughter who lives in Melbourne. His wife, Fiona, is a modern languages teacher and a former Jira tutor at Melbourne University’s Ormond College.

* * *

A solar astronomer from the Beijing Astronomical Observatory, Mr Wang Jia-Long, is working with the Division of Applied Physics for a year under the auspices of the Australia-China Council. Mr Wang is a graduate of the University of Beijing, and has taken part in two eclipse expeditions within China.

The Australian Physicist, Vol 18, September 1981 — Page 163
Dr. Donald Robertson, who was appointed Queensland University's first full-time Radiation Officer in 1973, retired from the University on July 31. He plans to continue work on a long-term ultraviolet research project.

The new Radiation Officer will be Mr. Bernard Perrett, formerly a University lecturer in physics, who was seconded to the Queensland Radium Institute in 1970, and has been chief physicist there since 1974.

Dr. Robertson joined the University in 1938 as physics lecturer and assistant to Professor Hugh Webster in a University-Brisbane General Hospital-Queensland Cancer Trust service to deal with physical aspects of X-ray and radium treatment in Brisbane.

He continued with this work after the foundation of the Queensland Radium Institute in 1944 as physicist-in-charge for an increasing team of physicists and technicians.

Dr. Robertson was involved with the University's radon laboratory. This laboratory is now located at the Royal Brisbane Hospital. He was also engaged with the late Keith Stevens in developing a personal radiation monitoring service for people using radiation in Queensland and Papua New Guinea.

Dr. Robertson and Professor Webster assisted in the framing of Queensland's Radioactive Substances Act in 1961 which regulates the use of radioactive materials and X-rays.

Under the act, almost all use of ionizing radiation (X-rays and rays produced by radioactive material) must be under the direction of a person holding a State radiation licence.

There are licensees and radiation safety officers in the 30 university departments using ionizing radiation and X-rays.

The departments include medical departments (for diagnosis and treatment of human illness); scientific departments, such as biochemistry, physiology and anatomy; veterinary groups (using radiography in animal treatment); biologists, botanists, engineers, physicists and other scientists.

Recently there had been growing use of other types of radiation, such as lasers, microwaves, ultraviolet and infra-red rays in University departments and experiments.

These were non-ionizing radiations, which were presently not covered by legislation.

"Many people believe that radiation is dangerous, probably as a result of exaggerated reporting in the daily press," Dr. Robertson said.

"It is only dangerous when not used in a safe manner, and I have never met any radiation situation which cannot be managed safely."

"I do not know of any radiation usage in Queensland which could do as much harm as a few ordinary pins in the wrong part of the body or a child with a box of matches."

Associate Professor R.S. Crisp of the physics department at the University of W.A. has been appointed Dean of the Faculty of Science. He has just attended conferences in Canada and the USA on electron transport in metals at low temperature physics.

Emeritus Professor Sir Rupert Myers graduated from the University of New South Wales on 31 July with the honorary degree of Doctors of Letters. The special graduation ceremony marked Sir Rupert's retirement after 12 years as Vice-Chancellor and Principal and a total of 29 years on campus.

A young Melbourne physicist, Stephen Prawer, has been awarded the inaugural John J. McNeill prize, established as a memorial to John McNeill, a research scientist with the Division of Applied Physics, who died last year.

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**Physics Roundabout**

**Triple Axis Spectrometer Workshop**

A very successful workshop giving hands-on experience in operating the triple-axis spectrometer attached to the HIFAR reactor at Lucas Heights was held on April 5th to 9th. The object of the workshop was to stimulate greater awareness of the capabilities of the spectrometer for research, the preparations which have to be carried out before experiments are undertaken and to provide some basic experience in operating the instrument.

Inspiration for the course and a major part of the planning and execution was generated by Dr. M.C.K. Wilshire of the Department of Solid State Physics at the Australian National University. In this he was assisted by Dr. M.M. Elcombe and Dr. C.J. Howard of the AAEC, Professor T.M. Sabine of the NSWIT and Dr. R.L. Davis and Dr. F.H. Moore of AINSE. The workshop was organised by AINSE and involved some collaboration with the Australian Neutron Beam Users Group.

The workshop consisted of six lectures and thirty hours of practical work. It was attended by sixteen scientists from the University of Melbourne, Monash University, the Australian National University, the Royal Military College, Duntroon, CSIRO, Newcastle University, University of Queensland and NSWIT.

In the time available the class split into three groups and operated the instrument in turn, checked the zero calibration, mounted a SrF, single crystal and measured the resolution function of the instrument. After these preliminaries, acoustic and optic phonons in the [001], [110] and [111] directions of SrF, were measured.

A follow up survey of participants indicated that the efforts of the organisers were well worth while, and further workshops of this type would be both constructive and well supported.
Academy plans contribution to the 1988 Bicentenary

CSIRO staff have been invited to assist the Australian Academy of Science's plan to contribute to the 1988 Bicentennial of Australia. A number of staff members have been invited to contribute an interpretive essay dealing with the history of science and applied science over the 200 years since 1788. The Academy wants the essays to cover the theme of Western science and the Australian experience since the continent's discovery by Europeans, including the impact of the discovery on the European scientific imagination.

Among specific topics to be covered in the proposed publication are:

- the influence of Australian natural history on European scientific thought.
- the changing pattern of support for science, including relationships between the state departments of agriculture, the universities, CSIRO and scientific societies.
- economic aspects of research, including differences in science for agricultural and manufacturing industries.
- Australia, Antarctica and the Great Barrier Reef.
- Australian contributions to international science.

In a form letter sent to individuals with an interest in the history of Australian science, the Chairman of the Academy's History of Science Committee, Professor J. M. Swan, proposed that a conference be held in August 1982 to discuss the general project with those interested.

He proposed that the publication of the book would coincide with the 1988 Bicentenary celebrations.

"In addition to the projected volume of essays, the Committee is considering the publication of a "Handbook of Australian Science" which would contain a wide range of factual material dealing with aspects of the development of Australian science, some statistical material, a collection of short bibliographies and would be modelled on the "Handbook of American History" published by Harvard University," Professor Swan added.

The retiring Chief of the Division of Entomology, Dr Doug Waterhouse, is a member of the Academy's Committee.

A special grant at the beginning of this year from the University's General Development Fund has allowed a team of four designers and technicians from the UCC to build new electronic circuitry to complement the optical fibre.

The new circuitry will eventually save hundreds of thousands of dollars in rentals of signal-processing equipment, and will also make it possible for users of small computers to 'plug in' to larger computers anywhere on campus when necessary, resulting in huge savings in duplication of equipment.

Fibre optics, is essentially, a matter of shining light down a tunnel with reflective inside: a 'strobe' light, pulsing at thousands of millions of times a second, shines directly into the tunnel, and digital information is conveyed by the absence or presence of a pulse travelling from one end of the tunnel to the other. However, it is all on a very small scale: the tunnel is no thicker than a fine length of fishing line, and a microscope is needed to slice pieces of this delicate glass 'wire' together.

The UCC's Network Manager, Mr Brian Rowsell, said the suggestion to install a very high bandwidth trunk around the University was first made in 1979 by Dr Bruce Haddad, who was Director of the UCC until early in 1980.

'Dr Haddad suggested that such an installation could solve a lot of the University's computer resource problems, now and in the future,' he said.

Mr Rowsell, who was then a member of the applications group of the UCC, visited Monash University, which is well advanced on a network design using conventional cable, and sought advice from Telecom's Research Laboratory in Melbourne on the use of optic fibre cable.

'The Faculty of Engineering wanted to create a new laboratory with 20 visual display units (VDUs) running at 2,400 baud (2,400 bits per second) next door to an existing laboratory with 20 printing terminals running at 300 baud.

'This could have been done using telephone connections, but because of the high speeds involved, it would have cost anything up to $14,000 a year to rent the necessary electronic equipment from Telecom.'

'Rather than go into that kind of expense, we made a further application for development funds, and at the beginning of this year the Deputy Vice-Chancellor, Professor Taylor, assured us in obtaining a grant to allow the work to go ahead at full speed.'

'It is not necessary to use modems with optical fibre. They are replaced by 'node computers' at either end of the line. A node computer at one end can receive signals from dozens of different terminals and send them down a single cable to the other end.

'The node computer accumulates characters typed into a terminal until the line is complete', said Mr Rowsell. 'It then sends the line down the high-speed trunk as a 'packet' of information in digital form.

'Each packet contains the source and destination addresses and a "cyclic redundancy check" (CRC).

'It is passed from node to node along the network until it reaches its destination. As a safeguard, a node computer will request the retransmission of the packet if the CRC detects any interference with the message.

'As a safeguard for the network as a whole, the strands of optical fibre have been laid so that the paths are duplicated.

'This means that if one path fails, the nodes at each end will still have full communication via the duplicate path.'

The Australian Physicist, Vol 18, September 1981 — Page 165
Scientists are Needed at Top

Australia — and the world — would be a better place if more scientists 'broke loose' from their laboratories and sought roles as top policy makers.

That was the message from CSIRO Chairman, Dr Paul Wild, to some 200 graduates from the physical and biological sciences at the fifth and last of this year's graduation ceremonies at La Trobe University.

He said many people blamed most of our industrial problems on trade unions which seemed to look after the interests of their own special flock rather than the national workforce as a whole.

This, of course, contributes heavily, but I wonder whether management should share a good part of the blame — and for the same reason; that it concentrates on its own narrow interests. The top structure of Australian society — the people with the power, the politicians, the top industrialists and the top trade unionists — are sometimes sterling entrepreneurs who have fought their way up the hard way.

New Science and Technology Magazine

A monthly round-up of science and technology in Australia is now available in a new magazine, Scitech.

Scitech is produced in Canberra by Jane Ford, who is the former editor of the Australia Information Services' Science Newsletter.

It reports on university and CSIRO research, industrial research and government policy affecting scientific and technological research in Australia.

Subscriptions to Scitech are $70.00 a year or $40.00 for six months and can be obtained by writing to Scitech Publications, 51 Boobialla Street, O'Connor, ACT 2601.

Copies of Scitech can be seen in the Information Office, Ground Floor, Old Physics Building.

University of Melbourne Staff News July 1981
The Minister for Defence, Mr D.J. Killen, has released the reports of two reviews of the Defence Science and Technology Organisation (DSTO) that were submitted to him in November 1980, and the Government's response to their recommendations. An External Review, chaired by Dr A.L.G. Rees, former Chief of the CSIRO Division of Chemical Physics, examined the research content and the quality of the work of the DSTO, and its relationship with industry and other organisations in the Australian science community. An Internal Review, chaired by Professor P.T. Pink, the Chief Defence Scientist, examined the objectives and procedures of the DSTO and its interaction with the Defence Force and other elements of the Defence Organisation.

Mr Killen said that the two reports had been referred to the recently established Defence Review, chaired by Mr John Utz, as some recommendations were relevant to its terms of reference. The Government would take no decisions on those recommendations pending advice from that body (External Review recommendations 1-4, 6 and Internal Review recommendations 1-9).

Mr Killen said that the Reviews had identified deficiencies in the organisation, management, administration and operations of the DSTO. He was anxious to see these remedied. Most recommendations had been accepted by the Government. Wherever practicable the Government had given a definite response, including direction to the Department of Defence. However, some issues still required further work and consultation and some recommendations involved additional resources, which would have to be examined along with other claims on the Defence budget.

Mr Killen acknowledged that attention to short-term priorities had caused research, especially long-term research, to fall below a desirable level. However, he found some comments on the DSTO rather short-sighted and unbalanced. For example, the External Review reported "preoccupation with today's problems on the assumption that tomorrow's problems will take care of themselves" and had commented that this would "leave Australia at the mercy of overseas commercial interests who will relish the uninformed, uncritical defence customer such a policy will produce". Mr Killen said that he could not accept that Defence purchasing was likely to become "uninformed" and "uncritical". A high level of professional expertise in both the Defence Force and DSTO ensured thorough evaluation, as for example with the current project for acquisition of a new tactical fighter aircraft, and the Government had no intention of allowing these standards to fail.

Mr Killen pointed out that "today's problems" had to be dealt with. The Defence Force required help from the DSTO in the selection, support and management of its increasingly complex military equipment. DSTO was not simply a research organisation, although research was an important part of its functions.

In any case, it was just not true that "tomorrow's problems were being neglected." For example, DSTO's work in high-powered lasers and their interaction with materials, over-the-horizon radar and electro-magnetic propulsion, to mention just a few projects, were at the forefront of technology.

Mr Killen said he found comment in some other areas similarly ill-founded or ill-considered.

The Government accepted that the balance between research and technical support to the Defence Force needed adjustment. It was essential to maintain scientific standards and the data base from which all technical support was provided. But the need to support the Defence Force remained and had to be met.

Mr Killen said that the Government accepted the need to develop co-operation between DSTO and Australian defence industry. He was encouraging initiatives to this end. There were already a number of successful co-operative projects between DSTO and industry, and prospects for more in the future.

Mr Killen said that the Reviews gave a good deal of attention to internal organisation, administration, staff, financial and related matters. He was much in sympathy with the External Review's statement that "the Establishment needs a great deal more real delegation of authority" in these areas. The Department of Defence would open discussion with other authorities concerned and move for increased delegations and authority for heads of the DSTO establishments.

Mr Killen said he agreed with both Reviews that scientists in Government service required special working arrangements if innovation was to flourish. Both Reviews also stated that advancement for officers within the research scientist group in DSTO should be made on the basis of individual assessment. The External Review advocated even wider application of this concept.

Mr Killen said that a merit-advancement scheme for research scientists had been agreed in principle by the Public Service Board. His Department was examining this in detail and would be consulting with the Board further to implement such a scheme as a matter of urgency.

Mr Killen recalled that Government involvement in defence science began in 1910 with the establishment of a small chemical laboratory at Victoria Barracks, Melbourne. Now DSTO employed some 1000 professional scientists, engineers and experimental officers and 3800 technical, industrial and administrative staff. It was second in size only to the Commonwealth Scientific and Industrial Research Organisation. There were major establishments at the Defence Research Centre at Salisbury near Adelaide, and, outside Melbourne, at Fishermans Bend and at Maribyrnong.

Mr Killen said that DSTO commanded international respect and that the Government was proud of its achievements and of the dedication of its members to the task of providing the best possible scientific and technological support to the Defence Organisation. He said that he was confident that the reforms being introduced as a result of the Reviews would ensure a bright future for the DSTO.

Feasibility of wind power examined

Dr Brian Martin of ANU's Department of Applied Mathematics, Faculty of Science, working together with Dr Mark Diesendorf and Mr John Carlin of the CSIRO Division of Mathematics and Statistics, and Mr John Haslett, a visitor to CSIRO from Trinity College, Dublin, have made important advances in determining the economic value of wind power in electricity grids. They have set up mathematical models of large scale wind energy systems which are
interconnected with state electricity grids. Dr Martin and Dr Diesendrof believe that large-scale, grid-connected wind power may rapidly become economically competitive in part of Australia.

One of the traditional conceptions about wind power is the belief that the only economic value of wind power in an electricity grid comes from saving fuel in thermal power stations or saving water in hydro-electric storages. It used to be widely believed that a variable power source such as wind power required conventional power plant to be always kept in reserve as backup for the periods when the wind was not blowing.

The mathematical models and computer simulations of the ANU-CSIRO team have shown that this traditional view is no longer tenable. Conceptually, the crux of the problem is the recognition that to label conventional plant as 'reliable' and wind power plant as 'unreliable' is to make an unrealistic distinction. Both types of plant are unreliable to some extent and both require some backup capacity.

The contribution to grid reliability by each type of plant is quantified by introducing the concept of 'capacity credit', the amount of hypothetical, totally reliable power plant, measured in megawatts (MW), to which a given amount of wind power plant or conventional plant is equivalent in its contribution to the reliability of power supply.

Unexpected failures of conventional plant are the result of mechanical breakdowns, while unexpected 'failures' of wind plant result mainly from lulls in the wind. (The effect of occasional random breakdowns of individual wind generators in a large array of wind generators will be simply to reduce slightly the average power output of the array.) Although lulls in the wind tend to occur more frequently than breakdowns in conventional units, lulls tend to have shorter durations.

As a consequence of mechanical breakdowns, a small (say 200 MW) coal fired power unit will not be available to deliver power for perhaps 10 percent of the time each year, while a very large (1000 MW) nuclear powered unit may be unavailable because of breakdowns for 20 percent of the time.

In the recent power crisis in Victoria, five conventional units suffered simultaneous breakdowns. On the basis of the above probabilities of failure of individual units, it must be expected that such an event will occur from time to time.

To quantify correctly the reliability contribution of wind power in an electricity grid, we had to take account of three separate probability distributions in the problem: the distribution of lulls and other variations in wind power, the distribution of breakdowns in conventional units and the distribution of variations in electricity demand. We also studied the effect of placing the wind generators at widely separated sites having different wind regimes.

Our results suggested that both the capacity credit and the fuel saving of wind power would be significant in determining the economic value of wind power in an electricity grid.

The next step was to determine whether wind power substitutes for base or peak load conventional plant. Base load plant is usually used to produce power around the clock; it has a high capital cost but a low fuel cost. Peak load plant is used to produce power only when necessary (especially during times of peak power use such as around 6pm); it has a low capital cost but a high fuel cost.

In the absence of wind power plant, there is an 'optional mix' of base and peak plant which minimises the total annual cost of the grid system (comprised of fixed charges, mainly interest on capital borrowed, and variable charges, mainly fuel).

When wind power plant is installed in the grid, this optional mix changes. We evaluated these changes and determined their effect on the economic value of wind power. We found that minimum annual cost is achieved when wind power substitutes for conventional base load plant, the plant with the highest capital cost. To maintain the same total grid reliability, some additional conventional peak plant has to be installed as well. This peak plant rarely has to be operated and so plays the role of a reliability insurance with a low premium.

There are five basic costs in the optimal mix problem: the capital costs of base, peak and wind capacity, and the variable costs of operating base and peak plant. We calculated the optimal mix for 36 different combinations of these cost parameters and found that the dollar value of the conventional base capacity that is displaced by wind power is often comparable with the dollar value of the fuel saved. This means that in some cases large scale wind power has an economic value which is double the value previously attributed to it.

The implications of this work for the future of large scale wind power in Australia and overseas are considerable. In large parts of northern Europe the costs of conventional base load fuel and power plants (especially nuclear capacity) are now so high that large scale wind power may already be economically competitive. Mass production of large wind generators is likely to commence in the United States in 1984 or 1985.

Once this occurs, it is possible that large scale grid connected wind power would rapidly become economically competitive in Western Australia, South Australia and Tasmania. Before 1990, a significant industry could be set up to construct wind generators for these three windy states.

ANU Reporter

1982 Churchill Fellowships

Fifty-nine Churchill Fellowships tenable in 1982 were announced nationally by the media in early July.

The Churchill Trust hopes that its Fellowships will not only benefit the recipient, but that any knowledge or expertise gained will be of wide benefit to the people of Australia. Anyone interested in a recipient's field of study is therefore invited to contact him or her before the study period.

There are five technical awards in the list, one on urban regeneration, one on underwater engineering techniques and diving systems, one on metallurgical and pollution control in iron foundries, one on fungal diseases in humans and animals, and one on boating weather forecasts and their communication to small sea-going craft.

Names and addresses can be obtained from the editor, or from the Churchill Memorial Trust, P.O. Box 478, Canberra.

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CONFERENCES AND MEETINGS

1981
Oct 22-23  Manufacturing Resources of Australia Canberra
AATS Executive Office, 191 Royal Pde, Parkville Vic. 3052

1982
Feb 10-12  6th Annual Meeting on Solid State Physics, Wagga, NSW
D.I.D. Campbell, CSIRO Div. of Chemical Physics, Box 160, Claynton Vic. 3168
Feb 15-18  1st Australian Conference on Archaeometry, Sydney
Dr. P. Duerden, AAE CRE, Sutherland NSW 2232

1983
May 30-June 3  International Conf. on Chromatographic Detectors, Melbourne.
Sec. International Conf. on Chromatographic Detectors, University of Melbourne, Parkville, Vic. 3052.

CHROMATOGRAPHIC DETECTORS

An International Conference, jointly organised by the CSIRO, Melbourne University, and representatives of the Australian scientific instrument industry, will be held at Melbourne University in May/June 1983. The conference will celebrate the 25th anniversary of the invention of the flame ionisation detector in Melbourne in 1958.

Seminar: Nicrosil/Nisil — New High Stability Thermocouple for Industry

Now, a new nickel base thermocouple, called Nicrosil/Nisil, has been developed at the Materials Research Laboratories in Australia. This thermocouple is said to overcome virtually all of the deficiencies of conventional thermocouples and has a proven track record in a diverse range of applications.

The aim of this seminar is to alert industry to the demonstrated advantages of the nicrosil/nisil thermocouple system. The seminar will particularly benefit those responsible for temperature measurement and control in all sectors of manufacturing industry and could result in an increase in their company’s productivity.

Speakers at the seminar are actively engaged in the development and promotion of nicrosil/nisil thermocouples in Australia.

Registration — $50 per person all inclusive.
Details — Dr Graeme Cocks, Technology Transfer Council, 370 St Kilda Road, Melbourne, 3004.
2-5 p.m. Melbourne 9th September, 1981 (03) 696 4204
Adelaide 7th October, 1981 (08) 212 3400
Perth 8th October, 1981 (09) 325 0111
Sydney 18th November, 1981 (02) 929 5566
Brisbane 19th November, 1981 (07) 31 2821

Conventional thermocouples, typically the base metal alloys, suffer serious limitations particularly with their poor stability in certain environments.

UNIVERSITY OF OTAGO
Dunedin, New Zealand

LECTURER IN PHYSICS

Applications are invited for the position of Lecturer in the Department of Physics. The Department has recently accepted responsibility for teaching some of the courses in Computer Science (most of which are taught by the Computing Centre staff) and will shortly increase teaching of electronics and microelectronics at postgraduate level. Consequently preference will be given to candidates with strengths and experience in these areas.

The appointee will be expected to pursue research in one of the fields currently pursued in the Department (atomic and laser physics, radio and space physics, environmental and applied physics), or in electronics. The Department has recently occupied a well-appointed, modern building and has several mini and microcomputers for teaching and research.

Salary Lecturer: $NZ19,140 — $NZ22,520 per annum.

Further particulars are available from the Secretary, General, Association of Commonwealth Universities (Apointments), 36 Gordon Square, London WC1H 0FF, or from the undersigned, P.O. Box 56, Dunedin, New Zealand. Applications quoting reference number AB1038 close in London and New Zealand on 30 September 1981 or as soon as possible thereafter.

D.W. Gilvan
REGISTRAR

Australian Journal of Physics

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TERM DATES 1982

Set out below are the term dates for Australian universities in 1982. The common vacation dates recommended by the AVCC are the weeks beginning – 10 May, 5 July and 23 August 1982.

UNIVERSITIES WITH TERM TIMETABLES

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<tr>
<th>University</th>
<th>1st Term</th>
<th>Exams</th>
<th>2nd Term</th>
<th>Exams</th>
<th>3rd Term</th>
<th>Exams</th>
</tr>
</thead>
</table>

* Adelaide – 1 March – 8 March is orientation week; Faculty of Medicine timetable varies.
** Flinders – 1 March – 8 March is orientation week; School of Medicine timetable varies.
++ Newcastle – Faculty of Medicine timetable varies.
+++ Sydney – Faculties of Medicine and Dentistry timetables vary.
++ Western Australia – Medicine, Dentistry, Social Work and Social Administration timetables vary.

UNIVERSITIES WITH SEMESTER TIMETABLES

<table>
<thead>
<tr>
<th>University</th>
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<th>Exams</th>
<th>2nd Semester</th>
<th>Exams</th>
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</thead>
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<tr>
<td>ANU</td>
<td>1 Mar – 30 Apr</td>
<td>17 May</td>
<td>11 June</td>
<td>12 July</td>
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<tr>
<td>Deakin</td>
<td>1 Mar – 7 May</td>
<td>17 May</td>
<td>3 July</td>
<td>18 July</td>
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<tr>
<td>Griffith*</td>
<td>1 Feb – 7 April</td>
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<td>21 June</td>
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<tr>
<td>James Cook</td>
<td>22 Feb – 12 Apr</td>
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<td>11 June</td>
<td>12 July</td>
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<tr>
<td>Macquarie</td>
<td>1 Mar – 7 May</td>
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<td>18 June</td>
<td>19 July</td>
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<tr>
<td>Monash</td>
<td>1 Mar – 30 Apr</td>
<td>17 May</td>
<td>18 June</td>
<td>26 July</td>
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<td>NSW**</td>
<td>1 Mar – 9 May</td>
<td>17 May</td>
<td>13 June</td>
<td>15 June</td>
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<tr>
<td>Queensland</td>
<td>22 Feb – 8 May</td>
<td>17 May</td>
<td>5 June</td>
<td>15 June</td>
</tr>
<tr>
<td>Wollongong</td>
<td>1 Mar – 9 May</td>
<td>17 May</td>
<td>13 June</td>
<td>21 June</td>
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</table>

* Griffith – 1982 timetable is affected by the Commonwealth Games – 30 Aug – 29 Oct Commonwealth Games period, no formal classes, access for staff and research students only.
** NSW – Faculty of Medicine timetable, other than for years I and II, varies.

These advertisements were unfortunately delayed — the mail strike.
The advertisers are aware of the discrepancy in closing dates.

THE PRINCE HENRY AND THE PRINCE OF WALES HOSPITAL GROUP
Teaching Hospitals of the University of New South Wales

Applications are invited for the position of Head, Department of Medical Physics, at the above Group of Hospitals.

An active and innovative person is sought to head a group of eight physicists with good technical back-up. The Department undertakes a wide range of support activities to clinical departments, with particular emphasis on Radiotherapy, Nuclear Medicine and Radiology.

In addition to daily patient care activities a strong research and development program exists in several area, including radiobiology, hyperthermia, nuclear cardiology and radiation dosimetry.

Excellent computing facilities are available.

Applications should possess postgraduate qualifications in Physics, and have a strong interest in instrumentation and computing. Previous experience in Hospital work a considerable advantage.

Salary in the range of $21,9875 to $34,231 p.a. depending on qualifications and experience.

Closing Date 14th August, 1981.
Enquiries: Dr. J. Stewart, 399-0111 ext: 4761

"THE AUSTRALIAN NATIONAL UNIVERSITY"

Research School of Physical Sciences

A number of Postgraduate Scholarships and Awards are available for full-time study leading to the degree of Doctor of Philosophy. Applicants should hold, or expect to hold, a degree of bachelor with at least upper second-class honours or a degree of Master and have a capacity for research.

The School consists of nine departments encompassing Applied Mathematics, Astronomy (Mount Stromlo and Siding Spring Observatories), Atomic and Molecular Physics, Engineering Physics, Mathematics, Nuclear Physics, Plasma Physics, Solid State Physics and Theoretical Physics.

Further particulars are available from the School Secretary, RSPhysS, P.O. Box 4, Canberra ACT 2600. Applications for 1982 close on 30 September 1981.