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Registered for posting as a periodical—Category B
JOURNAL COSTS

A number of economies have been used in the preparation of the July, August and September issues of the Australian Physicist. The desirability or otherwise of continuing these or other economies into 1974 will be decided at the AIP Council meeting on 1–2 November 1973. Readers should make their opinions known either through Branch or Group Committees or directly to Associate-Editors or the Editor of the Australian Physicist.

STUDENT AWARD

A continuing supply of reports on physics activities in Australia is needed to enable the Australian Physicist to serve its proper function. A special award of $20.00 will therefore be made for the best student contribution which is published by June 1974.

Students have seldom written for the Australian Physicist in the past but this can hardly be because of a shortage of worthwhile things to say. Reports of interesting lectures, seminars, conferences, projects or proposals and new or views relating to the role of physics and physicists offer plenty of scope for worthwhile contributions.

The award will be based on the interest to physicists in Australia and the effectiveness with which a topic is presented. Contributions should be annotated "for consideration for student award" and be submitted through an Associate-Editor.

EDUCATION GROUP – VICTORIAN SECTION

A Victorian Section of the Education Group has been set up to provide meetings on a regular basis for A.I.P. members in Victoria. At the first meeting, to be held on October 12th at 8 p.m. in Swinburne College of Technology, Dr. J.A. McDonell will speak on "The Open University – are its techniques adaptable to other areas of tertiary education?" Dr. McDonell is currently Director of the Centre for Continuing Education at Monash University and has recently returned from a 5-month stay at the British Open University.

It is also hoped to arrange displays of Open University material currently available in Australia. Coffee and biscuits will be served both before and after the meeting to assist members in browsing through the displays.

Further information on the meeting or the Section in general can be obtained from Dr. P.E. Clark, Physics Department, Monash University, Clayton, 3168.

"REPUBLIC OF SINGAPORE NEEDS BRAIN-POWER OF PHYSICISTS"

The Institute of Physics, Singapore (IPS) was formally registered on 2 August 1972 and launched with an inaugural dinner on 11 January 1973. The IPS has an initial membership of 215 including physicists from two universities (Nanyang University and the University of Singapore), other institutions of higher learning, schools and the Ministry of Education, other Government bodies, industry and management.

Speaking at the inaugural dinner, the IPS president (Professor Fusuke Soo, Nanyang University) drew attention to the need for improved communication amongst physicists in Singapore and for other activities to promote physics and its applications in Singapore. Early activities include the publication of a Bulletin, the formation of a standing-committee on education and plans for an essay contest in schools and the award of IPS medals to outstanding physics honours graduates.

Volume 1, number 1 of the IPS Bulletin contains IPS information, physics news and reports of recent lectures. The latter include a lecture by Professor J.F. Ward (James Cook University) on 'Radio Physics in Australia'. Professor Ward was visiting Singapore late in 1972 to test a large steerable aerial H.F. array designed and constructed at James Cook University.

The A.P. extends greetings to the IPS with the hope that communication between physicists in Australia and Singapore will also be improved.

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Non-members: $6.00 per annum (Australia),
$6.50 per annum (Overseas).

Single issues: $8.00 (Australia), $8.50 (Overseas).

All enquiries and correspondence concerning subscriptions to Australian Institute of Physics, PO Box 52, Parkville, Vic. 3052.

Advertising space instructions—forward to the Advertising Manager, J. T. O'Meara, PO Box 36, Bentliff Junction, NSW 2022, Telephone 02-389-2699. (Deadline—6th of month of issue).


Copy deadline—15th of month prior to the month of issue.

GRAND OU PETIT POUF?

More Australian physicists have been vocal more often on the 'French Tests' than perhaps any other topic. Public awareness and political action have been built on the scientific uncertainties but the tests have proceeded with a Gaullist contempt for contrary opinion. Whatever may be the influence on overseas opinions, there has been a marked impact on the thinking of many Australians.

Physical, biological and political (or ethical) questions are involved - a distinction that has been brought out in many discourses, including a talk by F. P. J. Robotham to the NSW Branch in March, and a series of colloquia recently held at Sydney University.

Physics

There is a general agreement on the magnitude of fall-out and the resulting radiation levels and some typical figures are given in Table 1.

The results for various years reflect the number and size of nuclear weapons tested in Polynesia and it seems likely that levels in 1973 will be similar to those of 1972 rather than to those of the earlier years in the French test program.

It is necessary to consider the whole-body dose and also the effects of specific radioisoopes which may have short half-lives (such as 131I) or long half-lives (such as 14C, 89Sr and 137Cs). The short-lived isotopes are usually contained within the troposphere and arrive in Australia about 12 days after a test. The long-lived isotopes arrive from the stratosphere on a considerably longer time scale. Meteorological conditions can affect the distribution of fall-out in various parts of Australia.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>A) Whole body doses without shielding (mrad per annum)</td>
<td>0.5</td>
<td>0.1</td>
<td>0.6</td>
<td>1.2</td>
<td>1.6</td>
<td>0.10</td>
</tr>
<tr>
<td>Perth</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>0.4</td>
<td>0.4</td>
<td>0.6</td>
<td>0.03</td>
</tr>
<tr>
<td>Hobart</td>
<td>0.8</td>
<td>0.1</td>
<td>0.5</td>
<td>0.6</td>
<td>1.3</td>
<td>0.05</td>
</tr>
<tr>
<td>Sydney</td>
<td>0.4</td>
<td>&lt;0.1</td>
<td>0.6</td>
<td>0.7</td>
<td>0.4</td>
<td>0.02</td>
</tr>
<tr>
<td>Townsville</td>
<td>0.4</td>
<td>&lt;0.1</td>
<td>0.6</td>
<td>0.7</td>
<td>0.4</td>
<td>0.02</td>
</tr>
</tbody>
</table>

B) Dose to thyroid of young children (mrad per annum)

| Perth                             | 83   | 16   | 23   | 35   | 35   | 1    |
| Melbourne                         | 28   | 5    | 10   | 12   | 6    | 0    |
| Brisbane                          | 53   | 11   | 26   | 15   | 16   | 1    |

(From Reports of National Radiation Advisory Committee, Atomic Weapons Tests Safety Committee, and Australian Academy of Science.)

The fall-out figures can be used to determine the dose commitments from French tests that have been carried out to date. These total approximately one mrad per annum to body tissue generally and 2 mrad per annum to bone tissue. The dose to the thyroid from 7 years of French tests is typically 12 mrad for adults and 120 mrad for young children. The highest recorded thyroid figures (in the Atherton tablelands) were about four times these typical figures.

Of course, other weapons tests have been carried out and other sources of man-made radiation occur. An idea of the relative magnitudes of radiation levels can be gleaned from Table 2.

These figures provide a lot of food for thought and with the increase in awareness of the hazards of radiation, it would be desirable to have complete information available for Australian conditions.

Biology

Damage to DNA and to chromosomes can readily be observed, but little is known about the effects of small quantities of radiation on man. With many kinds of damage mechanism possible, there is conflicting evidence concerning the importance of dose rate - even in experiments with large numbers of fruit fly. Also, the background rate of mutations can vary considerably, sometimes almost swamping the looked for effect.

Some of the damage can be repaired by normal processes, but these can have error rates varying from 1 in $10^9$ to as high as 1 in $10^3$. It is also necessary to consider the different properties of single damage events and of interactions between successive damage events. The latter would be expected to be dose-rate dependent but if, as seems likely, one event within a cell can cause a mutation and eventually a neoplasia, there can be no basis for a threshold theory of damage.

The response to radiation is idiosyncratic to species so that for man, information must be obtained from the relatively few cases of radiation exposure that have been studied. In this way a risk factor - at least at high doses - can be obtained. Approximately

<table>
<thead>
<tr>
<th>Natural Radiation: Total 100</th>
</tr>
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<tbody>
<tr>
<td>Cosmic Rays</td>
</tr>
<tr>
<td>Bodas potassium</td>
</tr>
<tr>
<td>Environmental radiactivity</td>
</tr>
<tr>
<td>Man-Made Radiation (USA, 1971) Total 119</td>
</tr>
<tr>
<td>Medical Diagnosis</td>
</tr>
<tr>
<td>Fallout</td>
</tr>
<tr>
<td>Therapy</td>
</tr>
<tr>
<td>Nuclear reactors</td>
</tr>
<tr>
<td>Radiopharmaceuticals</td>
</tr>
<tr>
<td>Miscellaneous</td>
</tr>
<tr>
<td>Occupational</td>
</tr>
</tbody>
</table>

(Estimated by US Environmental Protection Agency)

10^{-4} to 10^{-5} of a population exposed to one rad over a year could expect to develop, as a result, some sort of carcinoma in the following 20 years. This number would be swamped by the numbers of carcinomas occurring from other sources.

Although French advisers incline to the view that a threshold exists for radiation damage in man, most biologists working in the field do not support this view. Estimates of damage, such as those prepared by the Australian Academy of Science, are therefore usually based on the assumption that damage is linearly proportional to dose. Such calculations indicate that a few deaths per year could be the result of cancer or genetic damage caused by the French tests carried out so far. The increase in such estimates from 'les petits poufs' so far in 1973, is likely to be very small.

**Politics**

The balancing of risks incurred against possible benefits gained is a very subjective matter so that we have advice to the community varying from "no Australian need worry", to appeals for milk consumption to be curtailed. It seems however, that a majority of Australians, including physicians, fail to see benefits accruing to them from the French tests. No one in Australia need worry about French fallout, or, for that matter, Chinese fallout, either.

Having participated prominently in the chorus on the topic of harmful effects of radiation, perhaps physicists should now turn their attention to other sources of man-made radiation (e.g. Table 2). The concept that benefits should outweigh risks, requires a continuing application of new knowledge to the improvement of judgements on topics such as the rapid growth in use of X-rays and radioisotopes; the popular use of air transport; or even the variations in radiation levels with location, type of building materials and other factors. - R. Bird, R. Denahy

The scientist's primary responsibility to society is to present conclusions with the limit of intellectual honesty and objectivity that can be contrived, and with due consideration of the degrees of uncertainty attending his so-called conclusions.

**NEWS**

CARST

The Centre for the Advancement of Research by Science Teachers was established by G.R. Meyer of Macquarie University to encourage research in science, rather than in teaching methods, by practising teachers. Several meetings have been held over the last twelve months, at which suitable projects have been discussed.

The most suitable projects in the physical sciences appear to be environmental studies, such as monitoring of atmospheric pollutants, electrostatic field gradients near the surface of the earth, traffic density and field geology. The Education Group has kept in touch with CARST, and has offered advisory services and financial help.

**BIOLOGICAL MEMBRANES**

Scientists from 18 divisions of CSIRO met in Canberra last April for a seminar on Biological Membranes. The emphasis was on physical techniques, and delegates comprised physicists and chemists in addition to botanists, geneticists and physiologists. The range of the techniques being used to study plant, animal and bacterial membranes, is very wide: includes infrared spectroscopy, X-ray and electron diffraction, various optical methods, NMR and ESR and thermodynamic studies.

**SOLAR ENERGY STUDIES IN CSIRO**

A recent conference brought together scientists from 23 Divisions of CSIRO to review research in solar energy and to discuss the establishment of a special unit to coordinate future projects. Several officers of CSIRO, including R. Morse, Chief of the Division of Mechanical Engineering, later attended a conference at UNESCO, Paris, on Solar Energy Utilization.

**PHYSICS WEEK AT FLINDERS UNIVERSITY**

Approximately 2300 final year secondary school students from 70 South Australian schools attended Physics Week at Flinders University on 5-10 August. During Physics Week, which has been established as an annual event, matriculation physics classes, accompanied by their teacher, each spend 2 1/2 hours in the School of Physical Sciences.

Students see, and have demonstrated, six experiments selected from the Part I Physics Laboratory; then, working in groups of three, they perform some parts of one of the experiments. In addition they are shown a selection of three research laboratories, senior teaching laboratories, or workshops. A major objective of Physics Week is to help bridge the gap between school and university by showing the relationship between the physics taught and practised at each level. Students also have an opportunity to perform experiments relevant to their course using equipment which is often not available (in appropriate quantity or quality) to secondary schools.

**ANU AND THE ENVIRONMENT**

While the Committee to Save Black Mountain plans...
to spend $12,000 in a legal battle to prevent construction of a telecommunications tower, 118 staff members of the ANU Research School of Physical Sciences have released a statement asking for an independent re-examination of the technical aspects of the tower.

NEW SCHMIDT TELESCOPE OPENED

The 1.2 m Schmidt telescope at Siding Spring Observatory, NSW, was opened on 17 August by Professor Bengt Strömgren, President of the International Astronomical Union. The telescope will initially survey the sky from 20 degrees S to the southern celestial pole. The field diameter is 6 degrees and the aperture is f/2.5. Dr V.C. Reddish is the officer-in-charge of the telescope.

RESEARCH SCHOOL OF EARTH SCIENCES

A new School at ANU came into being on 1 July with Professor A. Hales as Director. Further appointments are expected later and these may lead to a strengthening of geophysics work at ANU.

ATOMIC ENERGY NEWS


A new catalogue of 122 films available for free loan may be obtained from the Information Services Section, AAEC, 45 Beach Street, Coogee, 0434.

NATIONAL SCIENTIFIC AND TECHNOLOGICAL INFORMATION AUTHORITY

A committee set up in 1971 has recommended to the Australian Government that a national authority be set up immediately to promote the rapid development of libraries, translation services, computer-based information services and related facilities throughout government and private organizations. The committee, chaired by Sir Samuel Jones, recommended that $3.5 million be spent over the first three years of the authority's existence.

FUTURE MEETINGS

Conservation and Exploration

A one-day symposium will be held on Saturday, 15 October at the College of Advanced Education, Hobart. The meeting is sponsored by the Geological Society of Australia, and should interest environmental physicists and geophysicists. Registration and enquiries may be sent to R. Tarryodas, Symposium Manager, Hydro-Electric Commission, Hobart.

Realistic Prospects for Solar Power in Australia

The Australian and New Zealand Section of the International Solar Energy Society is organizing a Symposium on "Realistic Prospects for Solar Power in Australia", to be held at Clunies Ross House, Parkville, Vic., on 22 November 1973. A series of papers on useful contributions that solar energy can make to Australia's energy requirements in the future will be presented by speakers from CSIRO, University and industrial research laboratories. Details of the programme and registration forms are available from W.T. Read, Hon. Secretary, ANZ Section, ISES, Box 26, Hightett, Vic. 3190.

NZ Electronics and Geophysics Conference

Papers on electronics and geophysics are invited (deadline for abstracts 31 Dec.) for a conference on 26-30 August 1974 in Auckland. There will also be an exhibition of materials, devices and systems. Advance registration forms are available from Nelson 1974, Centre for Continuing Education, University of Auckland, Private Bag, Auckland, NZ.

Earth's Gravitational Field

A symposium on methods and techniques for the determination of the earth's gravitational field and secular variations in position will be held at UNSW on 26-30 November, 1974. Information can be obtained from the AAS/IAG Symposium Committee, School of Surveying, UNSW.

ON WALKABOUT

Education Group

P. C. Ciddor will be overseas from the end of August until mid-November. During that time Education Group enquiries should go to J. E. Shaw, NSL.

Queen Elizabeth II Fellowships

P.V. Smith (Victoria University, Wellington) has received a fellowship to study electronic properties of disordered systems, at the University of New England.

A.E. Wright (CSIRO, Radiophysics) has received a fellowship for research on radio observational and theoretical astronomy.

Tide Theorist Returns to UK

D. Webb has left the CSIRO Division of Fisheries and Oceanography to take up a scholarship at the Institute of Oceanography and Tides at Liverpool. Whilst working at Cronulla he developed computer simulated models and tidal theory in a search for a better understanding of the way tidal energy flows through the ocean and how it is affected by resonances. For example a long wave which is the tide moves across the Indian Ocean through the Timor Sea and then circulates in the Gulf of Carpentaria where about 15 per cent of the world's tidal energy is dissipated. Other interest included the development of moonlight predictions and the use of techniques from nuclear theory to improve tidal predictions.
PROTON BEAMS FOR CANCER THERAPY

W. Turchinetz
Laboratory for Nuclear Science, Massachusetts Institute of Technology

There has been a renewal of interest in recent years in the possible applications of particle beams for cancer therapy. Facilities for the use of negative pions are under development at LAMPF (Los Alamos); TRIUMF (Vancouver); SIN (Zurich). One hopes at these new—and very expensive—facilities to conduct clinical studies to test the plausible arguments that were outlined some seven years ago by Fowler in his Rutherford Lecture. Some labs have also proposed the use of heavy ion beams, with their high specific ionization, for cancer therapy. In order to obtain suitable ranges of penetration, however, a GeV-type particle accelerator is generally required. Both at the Princeton-Penn accelerator and Berkeley 95N beams have been accelerated to energies such that the particle range in tissue is of therapeutic interest (up to 30 cm.).

Each of these possibilities has its advocates—indeed champions—and one expects in the next decade to have learned a lot of new radio-biology and to have started to assemble systematically clinical data on which judgments of medical efficacy can be based. If this timetable, prognosis if you like—seems pessimistic it’s useful to consider briefly the development of cancer therapy by more conventional beams—alpha and proton beams. An excellent summary is given in a recent paper by Koehler and Preston [1972].

The advantages of proton beams for cancer therapy were pointed out at least as early as 1946 by Wilson. Unlike X-rays and gamma rays, which exhibit exponential absorption once they reach equilibrium with their secondary radiations, protons traveling through matter have a well defined range which is dependent upon their initial energy. Because of their greater mass, they are not scattered as much as electrons and travel in nearly straight paths; their ionization increases as their speed gradually decreases. There is thus a greatly improved clinical definition of proton dosage over electron dosage and this advantage increases with energy or depth of dose. Much the same is true of both axial and lateral definition of the dosage.

In the years since 1946 only some 1,000 patients have been treated for a limited number of lesions. Most of the work has been done on an experimental basis in only a few places: Harvard, Berkeley, Uppsala, and in the Soviet Union. Yet the same period has seen a world wide proliferation of X-ray and electron facilities of steadily increasing voltages—recently a 48 MeV betatron has been put in use at the New England Medical Center and a 30 MeV electron linac is planned at Massachusetts General Hospital. Using modern technology a 185 MeV proton accelerator would cost a little more to install and run for medical purposes than a 30 MeV linac. Despite the elapsed years, the capital cost of radiation centers, the millions of cancer victims, one can quote Koehler and Preston, “... clinical work with proton beams has done little more than demonstrate that the gross effects

of such beams on both malignant and normal tissues can be predicted with reasonable accuracy from experience with conventional radiations, assuming that equal doses (measured in conventional rad units) are compared. We have shown that the use of high-energy protons or other heavy charged particles makes possible a substantial improvement in the control of the geometric distribution of therapeutic radiations, compared to supervoltage X-rays or electrons. Judging by the results of similar previous improvements, we can hope for better clinical control of some classes of malignant lesions as well as reduced complication rates if this advantage is exploited fully. We believe that an adequate clinical study should be undertaken at once, comparing protons to supervoltage X-rays applied to one or more types of malignant lesions in which it appears most likely that the improved dose distribution will be advantageous. It is important that such a study include enough cases to assure statistically significant results.”

These remarks argue for the new development of clinical availability of 200 MeV proton beams for therapeutic purposes, rather than further extension of the now conventional types.

Reference

GEC-ELLIOTT AUTOMATION
NUCLEAR DEPARTMENT

* CAMAC  * INTERFACES
*T NIM  * PERIPHERALS

Technical Information and Service from:
Warwick Barnard Sydney 439 1922
Michael Weller Melbourne 387 2811
Donald Hendry Brisbane 32 0441
Ross Deane Adelaide 71 7971
Steve Shapfer Perth 68 8566

The Australian Physicist, September 1973  145
MODULAR ELECTRONIC SYSTEMS FOR NUCLEAR RESEARCH

J. K. Parry
AAEC Research Establishment

A characteristic of nuclear instrumentation which now could be considered standard practice is the widespread acceptance and use of the plug-in modular concept in building up complex instrument systems. The nuclear physics community has always been quick to adapt the latest technological advances in electronics to their particular instrument needs and this attitude has undoubtedly influenced the move to modular construction. A brief review of the early efforts in this direction will assist in appreciating what are the important factors in current systems.

The Early Systems

Nuclear electronics emerged as an identifiable technology during the latter stages of the war and in the early post-war years. Development was accelerated by the various nuclear power projects initiated in the US, UK, Canada and France. Circuit techniques to process the fast rising, short duration pulses from nuclear detectors and provide the functions of pulse amplification, level discrimination, scaling, etc., were rapidly developed in the various national laboratories.

By the early fifties the technology was well established and instruments with respectable performance specifications although physically bulky were freely available. The mechanical construction of this era favoured valves and other circuit components mounted on a substantial chassis with a vertical front panel serving as a means of fitting the units into racks and carrying the controls and displays. Each unit was powered directly from the a.c. mains and because of the large power requirements and high d.c. voltages employed, they generated substantial quantities of heat. Panels of 19 inches width were normal, permitting units to be mounted in the standard Post Office style racks. Even a quite basic counting assembly would occupy several six foot racks and pose cooling problems.

As experimental requirements became more demanding and instrumentation systems more complex the concept of designing in terms of functional blocks, each performing one specific task, followed naturally. It was one further step to specify the electronic building blocks in similar unitized form and modular systems fed from a common power supply began to appear in the various laboratories. Historically it was the French at Saclay who first implemented the idea of physically identical, sub-units plugging into a 19 inch rack mounting assembly which housed the common power supply.
However, the first established systems appeared at the Harwell laboratories in the UK (the 2000 series) and at CERN in Switzerland in the late 1950's. The introduction of transistor circuitry with the resulting high packing density and low thermal generation provided the final and decisive boost to this concept.

Some of the Problems
Once accepted, the modular approach became very popular. National laboratories developed their own systems— Influencing commercial development in their own country. Large commercial firms developed their own range of units. Although the systems capability offered by any one of these schemes was very attractive and convenient it soon became apparent that the only characteristic shared by all was that of mutual incompatibility. Unfortunately this extended beyond the obvious points of difference of mechanical dimension, power supply voltages, etc., and included variations in signal levels and connector types.

These difficulties in utilising equipment from different sources were an increasing source of concern to users and manufacturers on both sides of the Atlantic; moves were taken to introduce some rationalisation. At the instigation of the National Bureau of Standards in the US, representatives of the major national laboratories formed the NIM Committee (Nuclear Instrument Module) which published the specification for the NIM scheme in 1964. Due to the major market represented by the initiating laboratories and the fortunate coincidence with the introduction of solid state equipment this scheme rapidly gained acceptance in the US and by 1970 had spread to nuclear equipment manufacturers throughout the Western world. Similarly in Europe at a meeting between representatives from Harwell and the ESONE Committee (European Standards of Nuclear Electronics) a level of signal compatibility was agreed between these two major systems in Europe.

With the lessons learned from these earlier efforts, implementation of the most recent international system, CAMAC, proceeded relatively smoothly. Development of CAMAC started when it became apparent that circuit integration and the small digital computer would have a major influence on methods of operating experiments and handling data. The ESONE Committee initiated a study to define the specification of a system suitable for fast data transfer and manipulation. Recognising that the cost and effort involved in introducing such systems would be enormous both ESONE and NIM Committees were appreciative of the advantages of an internationally accepted scheme and agreed to collaborate. In 1964 the official specification of CAMAC was issued by the ESONE Committee and in 1970 the NIM Committee endorsed CAMAC as a data handling system complementary to NIM.

The Necessary Compatibility Rules
At this stage it is worth reviewing the compatibility rules required for a particular modular system to be successful as far as the user is concerned.
Mechanical Compatibility. This defines the physical dimensions and tolerances permitted in the sub-units and the framework into which they are assembled. It includes provision for physically locating the sub-units and ensures correct connection via the electrical mating parts.

Power Supply Compatibility. This requirement defines the electrical power supplies available to the sub-units and the pin assignments on the mating electrical connectors.

These requirements are obvious and are found in all modular systems. They permit a unit to be inserted in any position in the receptacle and be operational when the power is on. A third requirement was perhaps not fully appreciated in all earlier systems yet is one whose importance cannot be overemphasised as far as the user is concerned. This is:

Signal Level and Connector Compatibility. Since the various operational functions are now separated into individual modules, these must be capable of being patched together in a completely standardised way. Signal outputs, whether analogue or digital, must drive inputs of other modules without the need for special buffer stages, without polarity problems and by means of defined connector and termination requirements.

A final level of compatibility which has assumed importance in recent years is:

Data Transfer Compatibility. This aspect will be discussed in some detail in a later section.

It is possible to compile an impressive list of the advantages conferred by a successful modular system. Some of the more important features are set out below.

- An extensive range of units from many sources of supply varying in cost and degree of sophistication.
- The ease of restructuring instrument systems allowing rapid evaluation of possible solutions to a measurement problem.
- Expansion and up-dating systems at minimum cost.
- The ease with which special purpose, laboratory built equipment can be incorporated.
- Reduction of equipment inventories and greater utilisation.
- Rapid replacement of faulty units.

The price paid for this flexibility is the increasing commitment to the particular system chosen. In the case of schemes which have gained widespread acceptance this has not been found to be a real restriction.

The two systems which can claim to be truly international by the extent of their use and manufacture are NIM and CAMAC.

The NIM System

The accompanying photograph shows a collection of NIM modules together with a NIM bin. The standard module has a basic width such that a standard bin will accommodate twelve single width modules. All multiples of the single width are allowable and can be inserted in any combination. There are two standard module heights specified, a nominal 5\(\frac{1}{2}\) inch (13.5 cm) and a nominal 8\(\frac{1}{2}\) inch (22 cm). The latter size is by far the more popular and is the height usually associated with the NIM system.

The bin is ruggedly constructed and is available with or without a power supply. The power supply when fitted is attached to the rear of the bin and since it provides substantial current capacity it is sometimes possible to slave an unpowered bin to the system to increase the unit capability. The specification requires that the power requirement of each module be marked on the front panel and the power availability of each bin be listed on the front surface.

Supply voltages of \(\pm 24\) V, \(\pm 12\) V and \(\pm 6\) V are standard and are bussed or parallel connected to all twelve rear connectors in the bin. Other facilities such as 117 V a.c., signal and power ground connections, etc., are assigned to dedicated connector positions.

In general the signal interconnection is carried out via front panel connectors using the 50 ohm BNC type. Connectors for high voltage applications up to 5 kV are also specified. Logic levels for transmission of digital signals and preferred analogue voltage ranges are listed.

The NIM system has found its main application within the nuclear physics community and has only extended into a few non-nuclear areas which have some contact with nuclear applications. Within its field however, it has been an outstanding success. All major suppliers of nuclear electronics in the USA and a majority in Europe offer equipment to this standard. The emphasis on nuclear applications means that most equipment is oriented towards processing signals from nuclear detectors. Within this limitation there is a comprehensive range of units offered providing the latest techniques in low noise amplifiers, energy analysis systems, timing analysers, data accumulation and presentation. As new circuit ideas and techniques appear it is a relatively painless operation to keep a complex instrumentation system up to state of the art performance by substitution of single units.

Figure 1

A collection of NIM modules from different manufacturers in a locally made bin. (See Advertisement)
The Data Handling Problem

CAMAC was mentioned earlier as the latest development in modular systems to receive recognition on an international scale. A significant feature of CAMAC which follows from its primary function of systematised data handling is that it is not confined to the nuclear field but satisfies a requirement that now exists in most areas where automated instrument systems are employed. A brief outline of the basic operation of CAMAC will allow its potential applications to be appreciated.

In CAMAC jargon the main components can be identified as:

The Crate. The standard crate is a 19 inch rack mounting structure not unlike a NIM bin but having 25 stations for accommodating standard plug-in modules. The crate also contains the wiring (the dataway) for interconnecting the modules and the power supplies necessary for their operation. In contrast with the NIM system where the bin wiring is used predominantly for distributing power and data transfers are via front connectors, the CAMAC wiring carries data, control signals and power.

The Dataway. This is the wiring that interconnects the 25 card-edge connectors at each station location in the crate. The connectors are a standard 86 pin type. Most of the wiring on stations 1 through to 24 is bussed and thus forms a party line to these positions. Pairs of lines (the N and L lines) fan out from the connector at station 25, a pair going to each location 1 to 24. These are private lines from special location 25 to each of the other module positions.

The Crate Controller. This unit is the master plug-in that controls the flow of signals within the crate. In order to achieve this it must have access to the bussed wires available at locations 1 to 24 and to the private lines available only at station 25. The crate controller therefore always resides at the extreme end of the crate occupying at least two positions, 24 and 25. The crate controller is an interface, one part of which controls the crate and its modules. These functions and the method of executing them are closely defined by the CAMAC specification. The other section of the crate controller provides for communication with the source of system control which may be a computer, a hardware control device or possibly even some simple control logic included in the crate controller itself. In general the CAMAC specification is not concerned with this section. (An exception to this statement is when a branch highway system is employed.)

The Module. These are the plug-in units which occupy any of the remaining locations 1 to 23. The front panel height is a nominal 8½ inch (22 cm) and a single width unit is one-half the width of a single width NIM module—slightly less than 1 inch (2 cm). The width of the basic CAMAC module is adequate to accommodate one printed circuit board with soldered-in integrated circuits. The length of the circuit board is about 12 inch (30 cm) to the tip of the 86 way printed connector. As in the NIM case, modules come in any multiple of single width. Note that, with the front panel dimensions compatible with NIM and the deeper CAMAC rack, it is possible to provide an adapter which allows NIM modules to plug-in to the printed circuit connector of CAMAC.

Modules again have two parts. One part is the section which performs the measurement or control task required by the instrument system, e.g., accumulating data, digitizing signals, controlling external devices, etc. The other part is the section which understands CAMAC and can communicate with the system control via the dataway and crate controller. Only minimal indication and control need be provided on the front panel since these

<table>
<thead>
<tr>
<th>Signal</th>
<th>Design.</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station number</td>
<td>N</td>
<td>Selects module. Individual line to each module.</td>
</tr>
<tr>
<td>Subaddress</td>
<td>A1-A4</td>
<td>Binary coded. Selects one of 16 possible locations in a module to which the command is addressed.</td>
</tr>
<tr>
<td>Addressed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function code</td>
<td>F1-F5</td>
<td>Binary coded. Defines one of 32 possible functions to be performed.</td>
</tr>
<tr>
<td>Unaddressed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initialise</td>
<td>Z</td>
<td>Sets module to defined state.</td>
</tr>
<tr>
<td>Clear</td>
<td>C</td>
<td>Clears registers.</td>
</tr>
<tr>
<td>Inhibit</td>
<td>I</td>
<td>Disables features for duration of signal</td>
</tr>
<tr>
<td>Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read bus</td>
<td>R1-R24</td>
<td>Transmits a word of up to 24 bits from module to crate controller.</td>
</tr>
<tr>
<td>Write bus</td>
<td>W1-W24</td>
<td>Transmits a word from crate controller to module.</td>
</tr>
<tr>
<td>Timing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>strobe 1</td>
<td>S1</td>
<td>Strobe for timing first phase of operation.</td>
</tr>
<tr>
<td>strobe 2</td>
<td>S2</td>
<td>Strobe for timing second phase of operation.</td>
</tr>
<tr>
<td>Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Look-at-me</td>
<td>L</td>
<td>Request from module to crate controller. Individual line from each module position.</td>
</tr>
<tr>
<td>Response</td>
<td>Q</td>
<td>A reply from module to certain commands issued by crate controller.</td>
</tr>
<tr>
<td>Busy</td>
<td>B</td>
<td>Indicates dataway occupied.</td>
</tr>
</tbody>
</table>

The Australian Physicist, September 1973 149
facilities can be available at the system control location and service a number of modules.

System Control. The CAMAC modules do not control themselves. The nature and capabilities of the system control will depend on the complexity and purpose of the system. In many cases the basic control may be contained in the programming of an associated computer — in others it may be a hard-wired controller.

Dataway Operation

A list of the signals available at each of the stations of a standard crate is shown in Table 1. Most dataway operations are commands issued by the crate controller. An addressed command is of the form NAF (refer to Table 1). The N signal is received only by the addressed station, the A and F signals are bussed and available to all modules present in the crate. The binary coded value of the sub-address A is decoded by the addressed module and thus N and A together denote the address of a specific register or logic function within the module. Up to 16 sub-addresses are possible.

F is the function code and is decoded to 32 possible instructions such as read, write, increment, enable, disable, test status, etc. The timing of the command is under the control of the crate controller via the strobe signals S1 and S2. With an appropriate allowance for settling times a typical command or data transfer is completed within 1 microsecond. Data transfers of one word per microsecond with up to 24 bits per word are possible.

Unaddressed commands (C, Z and I) are sent to all modules willing and able to obey them. As an example, the Z command would be the first operation performed after switching on the system.

The L (Look at me) signal is used by a module to call for attention, for example when a register overflows or an analogue to digital (A/D) conversion is complete. The crate controller knows immediately which module requires servicing and under system control executes the required actions.

The operations described so far refer to a single crate. Multi-crater systems are possible using a Branch Driver. Up to seven crates may be controlled by a branch driver and are connected in a daisy-chain configuration. The crate controllers may be of a standardised design and the special interface to the system control relegated to the branch driver.

It should now be apparent that CAMAC has all the advantages resulting from standardisation and compatibility rules already claimed and proven for NIM. Over 50 manufacturers are already supplying CAMAC equipment and to ensure continued standardisation both ESONE and NIM Committees have set up working groups to control hardware and software aspects of CAMAC development.

What other advantages are there? The obvious ones stem from the ease of associating CAMAC with a controlling computer. Interfaces (branch drivers) are already available for most of the small computers in common use. By a change of only the branch driver any CAMAC system can be connected to a different computer. Special modules are easy to design because the mechanical and power supply aspects are fixed and available. It is not necessary to know about computer timing requirements because CAMAC takes care of this. Since the software commands to CAMAC are well defined it is reasonable to hope that developments will allow most of the software to be written in a high level language and be computer independent.

Already a comprehensive range of module functions exist which extend beyond nuclear applications — input multiplexors, A/D and D/A converters of various types, registers, interrupt handlers, display and device drivers are but a few of the many designs appearing in manufacturers' catalogues, together with the basic CAMAC units such as crates, crate controllers and branch drivers.

CAMAC has already found application in medical electronics, meteorology, process control as well as the large and sophisticated systems installed in nuclear and high energy physics laboratories.

Further Information:

The CAMAC BULLETIN (ESONE Committee, JRC Euratom, I-21020 Ispra (Va) Italy) gives a product guide, articles and other information on CAMAC equipment and software and their uses. The first 'International Symposium on CAMAC in Real-Time Computer Applications' is to be held in Luxembourg from 4-6 December 1973.

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ANTINUCLUONE PHYSICS

D. C. Peaslee

Research School of Physical Sciences,
The Australian National University, Canberra

The general field of elementary particle and high energy physics has been in existence for about twenty-five years, although not always called by that title. Because of rapid development, this has been long enough for sub-fields to be already discernible: baryon and/or boson spectroscopy, strong interactions, weak interactions, ultra-high energies and asymptotic limits. Over the last half decade or so an emergent sub-field has been the physics of reactions induced by antinucleons (N).

A principal difficulty in antinucleon physics as contrasted with nuclear physics is the low density of available primary beams. In isolation antinucleons are as stable as nucleons; stable antideuterons and anti-He² have been produced. Like positrons, however, they are destroyed by annihilation in a predominantly nuclear world. Beams of antinucleons for experimentation must be obtained from nucleon-antinucleon pair creation on the spot at a high energy accelerator, in practice by collision of the primary proton beam with an internal target of some resistant material like tungsten. For antinucleon production the absolute kinetic energy threshold of the incident proton "becomes 5.6 GeV if the process is a nucleon-nucleon collision or 4.4 GeV if the process is a two-step one with the formation of a pion in a nucleon-nucleon collision followed by a pion-nucleon collision in which the nucleon-antinucleon pair is generated. These thresholds can be lowered appreciably by internal motions of the nucleons in the (heavy target) nucleus" [Chamberlin, 1966]. Through such means it was possible for the authors of this quotation to discover the antiproton at the Berkeley bevatron with a primary beam energy of just 6.2 GeV.

Although the bevatron enabled observation of antiprotons (p) — and soon afterwards, antineutrons (n) produced by charge exchange — the yields so close to threshold did not permit much secondary experimentation. This had to wait on the development of 25-30 GeV proton synchrotrons at Brookhaven and CERN. When these beams were eventually turned to production of antiprotons, a conventional internal target was used. The resultant p beam was much more copious than at lower machine energies, but also much more widely distributed in momentum. The higher intensity meant that a beam line for antinucleon experiments was now possible, and a number were engineered. The momentum spread was accepted as part of the situation, and no very extensive study seems to have been made to determine how to optimize this feature. In particular, most p beams fall off sharply in intensity at momenta ≲ 1 GeV/c, which proves to be a serious drawback as discussed below. It should be emphasized that at this stage—a decade ago—there was no cause to expect low momentum antinucleon reactions to be so recondite as they now appear. The hope was that increased intensity

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would be enough, and that momentum resolution would be of secondary importance.

As it now turns out, studies over the last five years have shown that antinucleon-nucleon (NN) reactions undergo a gradual change in the laboratory momentum range between 1 and 2 GeV/c. Above this region NN and NN reactions become increasingly similar with regard to cross section, angular distribution, and secondary products; but at the lower momenta they are quite different. For antinucleon physics there is accordingly a premium on beams of good intensity at low momenta, especially below 1 GeV/c.

Quite recently it has appeared that good momentum resolution will also be necessary. One of the channels accessible to NN collision is the direct formation of boson resonances. This channel is not too strongly coupled, so that resonance formation must compete with a strong background of multiple annihilation. In order to extract the resonances, reliance must be placed on interference effects and measurement of specific decay channels. Since small fluctuations may be important, good momentum resolution is essential to prevent these effects from being washed out. In addition, it is presently unclear whether the resonances are all broad, or whether weaker and narrower ones can also be detected.

The seriousness of the resolution problem is illustrated by the following example. At low momenta (about 450 MeV/c) there is evidence for the 'S resonance' in pp and pd reactions [Cline, 1968; Burrows, 1970]. This has been obtained from bubble chamber studies in which the reactions have been directly observed: backwards elastic scattering and annihilation into charged prongs. A measurement that lends itself to much higher statistics is direct transmission, which has permitted observation [Abrams, 1970] of a broad 'bump' in the T-U region (laboratory momentum \( \sim 1.3-1.8 \) GeV/c). For this measurement the target was a cylinder of liquid hydrogen about 1 meter long. Just recently a beam became accessible to this technique in the low momentum region of the S resonance—and nothing unusual was seen with this same target! Near the end of the run, however, a shorter target only one foot in length was inserted and an enormous S resonance showed up [Kycia, 1973]. Slowling-down effects in the larger target had so diffused its resolution that the resonance was no longer discernible.

The use of short targets means less target material and hence requires longer running times or stronger beams. Although beam studies are still needed, new detection techniques are developing that also hold promise. Spark chamber arrays can be triggered to specific configurations, the most popular so far being all neutral annihilation products from pp. This most often means n\(n\bar{n}\) mesons yielding 2\(\gamma\)-rays. A procedure that should display charged and neutral \(\pi\) mesons together is a two-compartment bubble chamber: the inner compartment filled with liquid hydrogen or deuterium target material, the outer containing the same liquid with enough dissolved heavier material (e.g., neon) to provide appreciable \(\gamma\)-ray conversion. An interesting recent development has been the report of a bound state of pn at about \(\sim 83 \) MeV [Gray, 1971]. This is of course a boson resonance, detected here by a peak in the distribution of recoiling protons from \(p_n\) on deuterium. This particularly simple case suggests searching for NN resonances by selecting on specific recoil energies and momenta of mesons or meson subgroups in antinucleon annihilation. The multiparticle spectrometer being developed at Brookhaven may prove very useful in this regard; in this case the information for analysis is brought home less on photographic film than on magnetic tape.

Since antinucleon physics in the \(\leq 2 \) GeV/c range is at the low end of the high energy physics spectrum, it has been largely bypassed in the rush to asymptotically high energies. Remote users' groups need therefore not fear intense competition from groups closer to an accelerator. At the same time, antinucleon physics provides a nearly ideal example of physics research: resonances expected from all we know about Regge families of bosons, still recondite but susceptible to discovery by refinement of techniques, which it is the physicist's challenge to find.

In an era of increasing social concern with science, the value of antinucleon study on an academic scale is as a frontier of pure physics. All social benefits of physics stem ultimately from original developments in pure physics, which discipline is kept alive only by continual striving to extend the boundaries of its knowledge. Antinucleon physics currently offers to users' groups the opportunity to breach one of the most profound frontiers with modest means.

References


PHYSICS IN TECHNOLOGY

FINE ADJUSTMENT BY VISCOUS DRAG

Simple devices with a wide range of uses may have as much impact on technology as more complex and sophisticated systems with only limited application. One such simple device has emerged recently from NSLI. This takes the form of the common concentric fine-tuning knob on an instrument drive, but which achieves the drive reduction ratio by use of viscous drag instead of gears. The drive to the driven shaft is through shear of a viscous film and the driven shaft is also braked by shear of a second film. The reduction ratio depends on the ratio of the shear stiffnesses of the two films which depend in turn on the areas, thicknesses and viscosities of the fluid films used, which may be varied to suit the design. Reduction ratios up to 5000:1 have been achieved.

Provided that inelastic fluids are used the drive is free of back-lash, hysteresis and stick-slip motion. It could be adapted for translational as well as rotational movement and could be made by any competent laboratory workshop. The device is aesthetically satisfying to use and for its full appreciation needs to be handled rather than read about.

WOOL FIBRE FINENESS MEASURED BY ACOUSTIC ATTENUATION

Amid the controversy surrounding the marketing of wool in recent years has been the question of Objective Measurement. In order to test wool on the basis of anything other than the subjective evaluation of a classifier it is necessary to physically measure those properties of a fleece which are relevant to its textile performance both in manufacturing and use. High among these properties in importance is the mean diameter or "fineness" of the fibres in the fleece, generally around 20 micrometres.

Sampling and measurement of individual fibres is impractical and until recently fineness measurement relied on a British instrument which measures the resistance to air flow offered by a plug of wool fibres. This can be related to mean fibre diameter provided that the conditions of measurement are closely specified and controlled. The British instrument is far from being portable or useable by unskilled staff. To overcome these disadvantages a cheap, portable instrument which does the same job has been developed by CSIRO and is now available in commercial form.

It uses a 50Hz sound wave, whose attenuation is measured after propagation through a standard plug of the wool sample. One advantage of such an oscillating air-flow over the previous uni-directional system is that it presents less of a problem with changing moisture content of the sample during the measurement. Two models of the instrument are available, one having an accuracy of 10.3 micrometres under laboratory conditions and the other an accuracy of 21 micrometre in field use when correction tables are needed for the effects of ambient temperature and humidity.

HEAT PIPES

The principle of the "drinking duck" toy which graced many a lounge bar a few years ago and which seemed sadly to have disappeared has been reintroduced in the form of a device to conduct heat rapidly away from places where it is not wanted. So-called heat pipes are sealed tubes containing a volatile fluid and a metal gauge "wick". At the hot end, fluid is vaporised and passes to the cool end where it is condensed and returns to the hot end via the wick.

Demonstration units can be purchased which have heat-transfer capacities of 100W and can be used at temperatures between 30°C and 150°C. A copper rod of the same size would have about five times the thermal resistance of the heat pipe. Heat pipes were designed originally for cooling electronic equipment of satellites but are now beginning to find industrial uses. - D.G. Morton

LETTERS

INTERCHANGE OF STUDENTS

SIR:- I should like to comment on the letter of Dr. J.G. Jenkin (Australian Physicist, April 1973) on the interchange of students between universities. I share his views that there are benefits to be gained from taking post-graduate and first degrees in different institutions and that these advantages outweigh the disadvantages.

The real difficulty appears to be not so much the attitudes of departments (although they are not always helpful) as the strong disinclination of students themselves to leave home. The experience of our University Scholarships Committee is that only a small fraction of interstate students perseveres with their application or accepts the offer of a post-graduate scholarship when it is made.

Be that as it may, I will undertake to place before our graduating students any material on postgraduate studies that my fellow Departmental Heads or Chairman choose to send me. All I ask is that they should do the same in return.

Department of Physics, J. R. Prescott
University of Adelaide, Adelaide, S. A. 5001.

IOP PLAQUE

SIR:- Featured in the Honorary Secretary's general comments of the 1972 Annual Report of The (British) Institute of Physics is the event of a presentation by the AIP of a plaque to The Institute "to commemorate the first visit from a President (of the Institute) (Dr. Menter) whilst in office (to Australia)". I was previously unaware of this event, but consider the
action peculiar and unnecessary 202 years after Cook.

CSIRO Wool Research Laboratories, LEO J. LYNCH
338 Blaxland Road,
Ryde. N.S.W. 2112.

QUEENSLAND GRADUATES

Sir,- The University of Queensland has recently been concerned at the relatively large number of graduates of the University of Queensland for whom we have no current address and to whom accordingly we are unable to forward voting papers for the election of members of Senate by Convocation. We are also unable to forward such information as the Vice-Chancellor's Annual Report on the progress of the University.

I should be grateful if you could include in your journal a request that any member who has not, within the past two years, received a voting paper or information from the University, should supply their current address. Some members may also be able to let us have the names of other members of Convocation, including married women, who are not currently receiving Convocation material.

Registrar,
University of Queensland,
St. Lucia. QLD. 4067.

S.A. RAYNER

Australian Institute of Physics

Notice to Members

ANNUAL SUBSCRIPTIONS

Members' 1974 subscription notices will be mailed to them early in October 1973. Prompt payment will be appreciated, particularly from those subscribing to the Australian Journal of Physics. For the convenience of members the subscription notice has been designed to allow its return in the same window-faced envelope after cancelling the previous postage and affixing new postage.

The use of bankers' orders is discouraged because it frequently results in double payment or other administrative difficulties. It is in the members' own interests that we recommend against their use.

The Institute of Physics

A major change in 1974 will be the collection directly by the IOP of their membership and journal subscriptions (see "The Australian Physicist", August 1973). AIP members of the IOP will receive subscription notices direct from London and are asked to communicate with the IOP on all matters relating to membership and journal subscriptions.

Australian Journal of Physics

Subscriptions to the Australian Journal of Physics may be paid through the AIP. The special rate for AIP members for 1974 is £7.50 provided it is paid before January 1, otherwise it will be £15.00.

Concessions

The following concessions are available to certain members on written application:

1. The subscription of an Associate or Graduate Member who is a full-time postgraduate student may be reduced to half.
2. The subscription of a member absent from Australia for a continuous period of 12 months or more, may be reduced to half (except in the case of a postgraduate student already paying a reduced subscription).
3. The subscription of a Member on National Service may be waived during the period of Service.
4. The subscription of a member who has attained the age of 60 years and has been a member for 10 or more years may be waived.

Benevolent Fund

The Institute maintains a Benevolent Fund to assist members, past members and their close relatives in case of need. It is hoped that the generous donations of the past will continue and that more members will contribute in this way; even the rounding off of your payment to the nearest dollar is appreciated. - J.K. MacKenzie (Honorary Treasurer)

IOP PUBLICATIONS

AIP members who wish to order IOP publications should do so directly from: The Institute of Physics, Bristol Publishing Office, 23 Marsh Street, Bristol, BS1 4BT, England. The following publications and subscription rates have been notified for 1974. The rates are in pounds sterling and payment should also be sent direct to London:

Journal of Physics A: Mathematical, Nuclear and General 54.00
Journal of Physics B: Atomic and Molecular Physics 54.00
Journal of Physics C: Solid State Physics 72.00
Journal of Physics D: Applied Physics 42.00
Journal of Physics E: Scientific Instruments 24.00
Journal of Physics F: Metal Physics 46.00
Physics in Medicine and Biology 24.00
Reports on Progress in Physics 56.00
Physics in Technology 16.00
Physics Education 9.00
Physics Bulletin 12.00
INSTITUTE AFFAIRS

EDUCATION GROUP

Two meetings have been held in Sydney this year. H. C. Carey (NSW Department of Education), spoke on "ASEP in Action" outlining the development of the Australian Science Education Project, which is nearing completion. B. M. Molness (University of Sydney) spoke on "Innovations in First Year Physics Teaching". He discussed the use of audio-visuals, Keller-plan courses, tutorials, diagnostic tests and a new course for biologically-oriented students.

The Group is co-sponsoring a meeting at the Blind School, North Rocks, NSW on 5 October which will discuss the development of science-teaching equipment suitable for the blind. Mr Carey would welcome suggestions from any source on this challenging and worthwhile problem.

The Group committee welcomes the initiative of P. E. Clark to organize meetings in Melbourne, and would be glad to support similar activities elsewhere in Australia.

VICTORIAN BRANCH YOUTH LECTURES, 1973

The 1973 Youth Lectures in Victoria were given by Professor W. A. Rachinger of Monash University, Physics Department, with the title "The Electric Properties of Matter". He made occasional references to the school work of the fifth and sixth form students at PSSC level and went on to treat more advanced topics.

The Metropolitan Lecture was given on 13 July at Clunies Ross House; the Gippsland lecture was given on 26 July at the Gippsland Institute of Advanced Education, Churchill and the Ballarat lecture on 8 August at the lower City Hall. In each case, about 400 students and teachers attended.

The AIP is grateful to Mr Cropsey of the Science and Technology Careers Bureau who advertised the metropolitan lecture, and to Keith Hamilton and Phil Higgins who arranged the Gippsland lecture. The hall at the GAE was full and the overflow was served by closed circuit television, kindly supplied by the State Electricity Commission. In Ballarat, Bill Durand had worked hard, notifying 72 schools in the 'district'. School parties came from Camperdown, Hamilton, Horsham, Donald, Ararat and Mildura (some 300 miles away).

One student, Ian Kinnersley came from Murrayvale on the State border, across the Big Desert. His High School must be amongst the most isolated in the State, and credit must be given to the enthusiasm of Ian and his parents who drove him to the lecture. Those members of the Victorian Branch Committee who attended the two country lectures were impressed by the keenness of the students and teachers to whom they talked.

The Victorian Branch Committee wants to keep the lectures going on a yearly basis; the present policy of having the Country Lectures given in one of the Colleges of the V.C. seems to be working extremely well. Professor Rachinger is to be congratulated on making such a valuable contribution to the experience of young science students. - H. C. Bolton

ASSOCIATION OF PROFESSIONAL SCIENTISTS OF AUSTRALIA

The APSA was formed in June 1960 with the primary objective of obtaining minimum award coverage for all qualified scientists. Registration with the Commonwealth Conciliation and Arbitration Commission was applied for immediately, but not achieved until November 1962 after protracted and expensive legal proceedings. The APSA thus became the only exclusively professional organisation to obtain such registration to cover all scientists employed in private industry.

The first Professional Scientists Award was obtained in 1964. Its terms include a minimum salary standard for Diplomates, Graduates and Experienced Scientists. The current award rates are shown in Table I. The Association is also a party to a number of other awards with similar terms to the Professional Scientists Award. These include: The Professional Scientists (Vehicle Industry) Award; Metal Industry Award 1971 - Part IV - Professional Scientists; The Aircraft Industry Award 1955 - Part II; and the Professional Scientists (Hydro-Electric Commission of Tasmania) Award 1965. All of these awards have been regularly maintained.

In conjunction with the Professional Officers Association (POA) (Commonwealth Public Service), the APSA is a party to Determination No. 76 of 1963 which sets rates to be paid to scientists employed in the Commonwealth Public Service. As a result of claims by both Associations, the Public Service Arbitrator increased scientists' rates by 8% as from February 22nd 1973. Current rates in the Commonwealth Public Service are shown in Table 2.

The private industry awards for scientists are patterned on the corresponding Engineers Award, in that they only specify base-grade levels. Equivalent work values for engineers and scientists for the purposes of the award were found to exist by the Public Service Arbitrator in various decisions. This has meant that the APSA has not had to engage in the

The Australian Physicist, September 1973. 155
expensive legal proceedings in which the Association of Professional Engineers, Australia (APEA) has been involved.

The current membership of the APSA is approximately 1500, which represents a fairly small proportion of eligible scientists. It is not until the Association's membership is substantially increased that it can represent scientists more fully in the various salary tribunals, without being totally dependent on prior movements in the engineering area.

All scientists with a 3-year science degree from any Australian, New Zealand or United Kingdom university, or an equivalent qualification, are eligible for membership of APSA, provided they are employed in any of the following scientific disciplines: physics, chemistry, geology, biochemistry, metallurgy, microbiology, chemical engineering and agricultural science. In deciding on the equivalence of other qualifications, the Association is guided by the recognised scientific institutes: Australian Institute of Physics, Royal Australian Chemical Institute, Australasian Institute of Mining and Metallurgy and the Australian Institute of Agricultural Sciences. The awards specifically name these Institutes as qualifying bodies for the purposes of award coverage. The annual subscription to the Association is $26.00, but concessional rates apply to members of the Professional Officers Association (Commonwealth Public Service).

The APSA employs a full-time Executive and Industrial Officer, and has its offices at 114 King Street, Melbourne, Vic. 3000. In addition to maintaining its various awards, the Association frequently represents members in individual negotiations with employers. Several members have benefited from APSA intervention in matters of long-service leave entitlements and severance pay arising from retrenchments. Again, however, success in the prosecution of its claims and other activities depends largely on the strength of the APSA measured in membership numbers. - Leo M. Bockh, Executive and Industrial Officer.

### Table 1

<table>
<thead>
<tr>
<th>Qualified Scientist</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Diplomat</td>
<td>4704</td>
</tr>
<tr>
<td>(b) Graduate (3-year course)</td>
<td>4852</td>
</tr>
<tr>
<td>(c) Graduate (4 or 5-year course)</td>
<td>5200</td>
</tr>
<tr>
<td>Experienced Scientist</td>
<td>7223</td>
</tr>
</tbody>
</table>

(The years of experience required for a Qualified Scientist to become an Experienced Scientist are 6 years, 5 years and 4 years for categories (a), (b) and (c) respectively.)

### Table 2

<p>| Actual Salary Rates ($) payable in the Commonwealth Public Service |
|--------------------------|----------------|------|------|------|------|------|------|</p>
<table>
<thead>
<tr>
<th>Class</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
<th>Step 5</th>
<th>Step 6</th>
<th>Step 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5258</td>
<td>5437</td>
<td>5902</td>
<td>6367</td>
<td>6899</td>
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### BOOK REVIEWS

LOW ENERGY ELECTRON SPECTROMETRY,

Reviewed by D. Youngman, School of Physics, University of New South Wales.

Methods and instruments for electron energy spectrum analysis and electron detection have advanced considerably in the last decade. This progress has made possible highly accurate electron spectrometric studies at very low energies, with consequent investigations of new topics and improved work on older topics such as atomic level widths.

This text, written in pleasant and informative style, gives an extensive coverage of advances that have been made in the field. The topics treated comprise two main subject areas: electron spectrometry instrumentation, and a review of topics such as Auger, Coster-Kronig and autoionisation effects, internal conversion of nuclear transitions, work related to atomic recoil following alpha decay, natural width of atomic levels, atomic electron binding energies and electron energy losses due to scattering in solids. The considerable information available on these topics from other fields such as X-ray and ultra violet spectroscopy, thermal neutron scattering and the like is integrated into the discussion. The text includes useful tables of atomic electron binding energies, accuracy comparisons of chemical analysis techniques, X-ray and UV resonance line energies, electron scattering cross sections etc.

The author has adopted a 'historical descriptive' style which makes somewhat more human reading of what could easily be a dry technical subject. The book is a most valuable reference guide with quite extensive detail for specialists working in the fields of electron and X-ray spectrometry and related areas. The printing and paper are of superior quality and are probably contributory factors to the high price which will unfortunately limit the book to mostly library purchase only.
Reviewed by K. J. Auburn, Wollongong University College, Wollongong, NSW.

"In taking the quantum mechanical point of view one supposes that there are certain types of particles in nature and that, for each type, a field theory exists much like that of E & M. In fact the photon is such a particle".
This quotation from the introduction to the final chapter of this publication appears to be the raison d'être for yet another book on Classical E & M. The material of this chapter (60 pp.), which describes the theories for the two component neutrino, the electron-positron and the photon would be profitable reading for any honours physics undergraduate in an Australian university. It is the only chapter which has an original flavour. The ten preceding chapters are probably only a suitable text (as opposed to reference book) for students of the two authors. It is unlikely that they would represent a choice of material to the liking of other lecturers.

The book is described in the preface as a textbook on the principles of electricity and magnetism written for graduating graduate students in physics. The authors would have served Australian students better by producing a short monograph on their own special interest as described in the final chapter to supplement one of the classical texts on electricity and magnetism. Nevertheless this publication could be a useful addition to a departmental library.

CLASSICAL AND MODERN PHYSICS, vol. I.
Reviewed by W. A. Miller, School of General Studies, Sydney Technical College.

This is the first of a three volume text designed to be used in a three semester college course in classical and modern physics. Volume one covers Introduction to Physics, Mathematics and Mechanics, volume two Thermodynamics and Electromagnetism, and volume three Relativity and Quantum Mechanics.

This volume is comparable, both in the standard reached, and the material covered to the well known text by Halliday and Resnick. It differs from their book however by giving in the first chapter a brief overview of physics. The next five chapters deal with concepts (from mass, length and time to energy and charge), elementary particles, the conservation laws, mathematics (most of kinematics is in this chapter) and vectors. The next chapter starts with Newton's laws and the remainder of the volume follows the usual sequence.

The students will probably find this book easier than Halliday and Resnick as they are led more gently than is usual into the mathematical description of physical phenomena. In most sections there are worked examples, and each chapter is summarised. This is followed by a large number of questions, exercises and problems for the student to attempt. Most exercises and problems are used to develop the work covered in the chapter. SI units are used, with the addition of kilocalories, the astronomical unit and the electron volt.

If you use Halliday and Resnick have a look at this book it may suit you better.


This book is written for students but it is also an excellent handbook for the occasional electronicist. The text is concise, illustrations are clear and the index is comprehensive. The subject is covered from the principles of semiconductor devices to the use of modern linear integrated circuits with worked examples of circuit design.


A paperback edition of the Third Edition of this familiar book, which was first published in 1946, is now available.

A small number of minor corrections, revisions and references have been made and added. These include a revision of the discussion of Schrödinger's equation in 23.07, and references to Isotropic Tensors in note 3.031a the Addenda.

AN INTRODUCTION TO THE IONOSPHERE AND THE MAGNETOSPHERE, J. A. Ratcliffe, Cambridge University Press 1972. 1x + 256 pp. £4.00.

Reviewed by J. H. Piddington, National Standards Laboratory, Chippendale, NSW.

Studies of the ionosphere extend back for half a century, during most of which time it has been visualized as a relatively thin atmospheric shell, of radial extent perhaps 1000 km. In contrast, the magnetosphere has been studied for a much shorter period but extends away for distances in excess of 100,000 km. Ratcliffe has adopted a recent definition in which the whole magnetosphere is included as part of the ionosphere; others have referred to the ionosphere as the lower boundary of the magnetosphere. These definitions seem to reflect the main interests of the authors, and Ratcliffe's is apparently in the ionosphere.

In introducing a student to this subject I would prefer to stress the general physical conditions and processes which describe the magnetosphere and its lower boundary layer. Ratcliffe has not omitted these, but much of the book is concerned with details which seem unnecessary in an introduction. For example, more than ten pages (and the plates) are devoted to whistlers, which are a class of low-frequency radio waves, while less space is devoted to ionospheric and magnetospheric current which are the basic dynamical components of the whole system.

On the other hand, I recommend this book to workers in related fields for a lucid account of many interesting physical phenomena.
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Edited by
Frank S. Barnes

This IEEE Book of Selected Reprints is designed to meet the specific needs of the serious student and the laser research worker. The student will find, for reference or review, a wide breadth of fundamental scientific papers that have become classics and a stimulating variety of contemporary papers. The engineer or physicist engaged in laser research will benefit from having the varied aspects of laser theory presented authoritatively and in depth in the carefully selected reprinted articles. Thus this volume will serve as both a text and reference book for years to come.

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