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President’s Column

When Louis Armstrong was asked where he thought jazz was going, his immediate reply is reported to have been “Man, if I knew I’d be there!” Something of this spirit necessarily pervades the same question asked about Physics and the answer involves considerations of style, of popular demand and of the influence of great performers of various types. Neither the question nor its answer lies within the domain of physics but rather of meta-physics, in the literal rather than the traditional meaning of that word. As physicists we can, if we wish, ignore the question and simply follow the road wherever it leads, secure in the reasonable assumption that the destination, if such a thing exists, will not be reached in our lifetime. In our idle moments however (if any one of us has such a thing these days) it is interesting to engage in a little philosophical speculation. This generally incurs the ire of professional philosophers, but they can be forgiven as they stand embattled on their ever-shrinking island.

Fortunately there is not room in this column for me to explore the matter in detail (shades of Fermat!). If physics is the ultimate science then one could argue that it is seeking the answer to the ultimate question, but what is that? (For further elucidation see “The Hitch-hiker’s Guide to the Galaxy” and “The Restaurant at the end of the Universe” by Douglas Adams). More realistically we might settle for the task of building models to approximate the behaviour of various physical systems, and then we must question whether any model less complex than the universe itself can ultimately be adequate.

Some physical model building has obvious purpose and limitations, like classical mechanics or non-relativistic quantum mechanics, and the application of these theories to specific problems. At the other end of the scale, I confess to sometimes wondering whether contemporary particle physics might not be tangential rather than asymptotic to reality, progressively creating its own new phenomena. It is not immediately obvious how this distinction could ever be satisfactorily established (or indeed, just what it means!)

Some University physics departments have courses or discussion groups dealing with these topics; perhaps some philosophy departments do too, though in my experience they are usually much more conservative in approach. Perhaps we should encourage our philosophical colleagues, perhaps we should expand into this field ourselves, or perhaps we should reserve such things for our retirement and get on with doing some physics while we still can.

Editorial

The Fifth National Conference of the Australian Institute of Physics will be held next month, 23-27 August.

To ensure that members have adequate time to review the programme, it has been published in this month’s edition, rather than the traditional practice of publishing it in the month of the conference. The vagaries of printing and posting deadlines would otherwise give members too little time to respond if they have not already done so.

The programme is certainly ambitious and timely. The opening address by Professor Karmel “Tertiary Education Funding — Implications for Scientific Training and Research” will be listened to eagerly by all. Funding cuts are forcing all institutions to carefully assess priorities and make hard decisions, and a glimpse of the future will be welcome.

At a time when the relevance of research is under scrutiny, the programme offers much, commencing with Applied Physics for the Future in Session A, through Alternative Energy Sources warranting two sessions and a workshop. Space Physics and Astronomly, and even a Nuclear War Forum. Physics Education and training in Developing Countries are also reviewed extensively. The Conference concludes with some crystal ball gazing, including a paper by Professor Max Brennan on “Physics in Australia Twenty Years from Now”.

The format of the Conference is a bold combination of learning situations. Thankfully, the endless days of endless streams of twelve minute resumes (plus three minutes of questions) have gone. Keynote speeches, poster sessions, workshops and visits are the modern methods of communication appropriate to a large and sophisticated Learned Society.

The organisers of the Conference are to be congratulated for their efforts.

John Barker.

The Australian Physicist, Vol. 19, July 1982 — Page 105
STEellar NUCleosynthesis WITH NEUTrons

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Introduction

The discovery of nuclear burning processes as the energy source for stars by von Weizacker (1938) and Bethe (1939) led to stellar models which, in turn, delineated conditions such as internal temperature. It became apparent that in ordinary stars the Coulomb barrier precluded significant element creation beyond the Fe group of nuclides. Concurrently, the slowly amassing body of data on terrestrial and solar elemental abundances gave conclusive evidence that abundances, with a prominent peak near iron, are not correlated with chemical properties.

In the 1940s, the rapid accumulation of nuclear reaction rates led to systematic data for activation cross sections of slow and fast neutrons. Alpher (1948), in collaboration with Gamow, observed an approximate inverse relationship between the capture cross sections for fission neutrons (E<~1 MeV) and the relative elemental abundances found in the solar system. A nonequilibrium model for element formation soon emerged, in which all the elements were formed by successive neutron captures in about 15 minutes in a primordial ‘big bang’. Although this model had several shortcomings, an intimate relation between neutron capture and element synthesis had been established.

Two observations in the 1950s helped set the stage for the next advance in stellar nucleosynthesis. In 1952, Merrill discovered atomic absorption lines of technetium in the atmosphere of type-s stars (red giants). Since technetium-99 has a half-life of less than one million years, this observation proved conclusively that nucleosynthesis by neutron capture is a dynamic, continuing stellar process. In 1956, a rough correspondence was noted between the spontaneous fission half-life of 244Cf (56 days) and the characteristic (approximately exponential) decay time (50 to 60 nights) of light from type-I supernovae (Burbidge et al. 1956). Multiple neutron captures must therefore occur in stellar explosions such as supernovae. While the hypothesis of 244Cf spontaneous fission as a major energy source for supernovae decay characteristics was probably inadequate, rapid, multiple neutron captures must have occurred to account for the solar system abundances of thorium and uranium. These elements could only have been produced in this way because short-lived isotopes (e.g. the neutron-rich astatine isotopes with half-lives of < 1 minute) lie between them and their stable progenitors.

Burbidge, Burbidge, Fowler & Hoyle (1957) and also Cameron (1957) integrated all the new ideas and information on element formation to produce a coherent picture. The location of heavy element synthesis was placed in stellar interiors and violent stellar explosions. Charged particle reactions were to be primarily responsible for element production up to the iron region. For heavier nuclides, two different neutron capture processes were proposed. For capture rates much slower than the β-decay rates of the unstable product nuclides, the slow or s-process was responsible for forming isotopes with abundances N_s(A) along the valley of β-stability. The s-process synthesis would feed on the 54Fe raw material in a low density sea of neutrons with average temperature of 2-3 x 10^6 K (or a Maxwellian energy of kT~30 keV). Beyond 60Fe, alpha decay terminates the s-process.

For capture rates very much faster than the β-decay rates, nuclides are formed near the neutron ‘drip’ line (where neutron binding energies go to zero) on the neutron rich ridge of the valley of β-stability. This is the rapid or r-process, and occurs under novae or supernovae conditions. At the end of the exposure, these neutron rich isotopes β-decay back to the stable nuclides, contributing the r-process abundance N_r(A) to the observed solar system abundance N(A).

Neutron induced reactions are also of significance for the production of some light nuclides. However, neutron capture reactions are of paramount importance in the production of most heavy nuclides. The quantitative nature of the s-process is based on the measurement of neutron capture across sections at astrophysical energies, and in this article the results of such measurements are reviewed with particular emphasis on Australian contributions. These data are also essential for the utilisation of nuclear cosmochronometers.

s-Process Nucleosynthesis

The major prediction of the s-process is the inverse correlation between solar system abundance and neutron capture cross section for neighbouring isotopes (Cameron 1955, Fowler et al. 1955, Clayton et al. 1961). The rate of change of abundance N(A)(t) of the s-process nuclide with mass number A depends on its capture rate σ<crs>(A), where σ is the capture cross section for neutron velocity v, the time-dependent neutron density n(t) and the abundance and capture rate of its lighter neighbour with mass number (A-1).

Expressed in terms of the time integrated neutron flux ρ (a measure of the total neutron bombardment per unit area) the production rate equation is

\[ \frac{dN_A}{d\tau} = N_{A-1} \sigma_{A-1} - N_A \sigma_A \]

This equation holds only if the β-decay lifetimes of the unstable product nuclides A are short compared to the mean time between neutron captures. Clayton, Fowler, Hull and Zimmerman (1961) showed that (N(σ)_A) (the subscript henceforth denoting s-process abundances expressed relative to 10^8 atoms of Si) should be a slowly varying function of mass number away from the magic neutron nuclides. This is clearly apparent in Figure 1 where the (N(σ)_A) data cover almost six decades for A = 60 to 210 (Allen et al. 1971). The data could not be fitted by assuming a single uniform exposure of the Fe seed. Rather, an exposure to a distribution of flux histories is required. The curve shown in Figure 1 represents a least squares fit to the (N(σ)_A) data by Seeger (1971) for the distribution of neutron
exposures $\rho(\tau) = 113.3$ $\tau^{+4}$ with a cut-off at $\tau = 1.84 \times 10^{-7}$ neutrons $\text{cm}^{-2}$. The function $(N_i, \tau)$ is a measure of the neutron fluence to which the seed nuclei have been exposed and $\rho(\tau)$ is the 'history' of the s-process synthesis. This history would include neutrons generated from $^{11}C(\alpha, n)$, $^{28}Ne(\alpha, n)$ and possibly $^{10}O(\alpha, n)$ reactions at temperatures in the vicinity of $2$ to $3 \times 10^9$ K, corresponding to a Maxwellian neutron temperature of $kT_{\text{e}} \approx 30$ keV.

In obtaining the $N_i(\tau)$ fit, estimated cross sections were assigned a factor of 2 uncertainty, as shown in Figure 1. The calculation adequately accounts for the s-process abundances of the Pb isotopes which have a high equilibrium component resulting from $\alpha$-decay recycling to $^{206}Pb$ from $^{208}Pb$.

Clear evidence of a ledge-precipice structure is also observed in Figure 1 at the magic neutron numbers $N = 50, 82$ and 126. The low neutron capture cross sections of the magic nuclides impede the progress of the s-process to heavier nuclides. There is, in fact, no single exposure or monotonic distribution of exposures which does not produce the observed discontinuities. Evidence for the $N = 82$ break is weak in Figure 1, but becomes much stronger when more recent cross section results are included, as shown in Figure 2 (Beer and Käppeler 1980).

Many of the data points in Figure 2 derive from AECB collaborative measurements with the University of Melbourne ($^{98}Mo$, $^{116}Cd$, $^{148}Ba$ - Stroud 1972), AINSE ($^{188}Yb$ - Allen & Cohen 1979) and Oak Ridge National Laboratories ($^{184}Pd$, $^{186}Cd$, $^{188}Ba$ - Musgrove et al. 1978a, b).

**Quantitative verification of s-process**

The $(N_i, \tau)$ correlation depends to a large extent on the relative elemental abundances which can be distorted by inderterminable amounts of physical and chemical fractionation over many gigayears. Also, r-process contributions $(N_r)$ to the observed abundances must be adequately accounted for in determining the s-process abundances.

The ultimate test of the s-process is the confirmation of the local equilibrium approximation (Cameron 1955, Fowler et al. 1955, Clayton 1964) i.e. $(N_i, \tau) = (N_i, \tau)_{\text{eq}}$ for s-only isotopes of the same element. One such case is the s-only tellurium isotopes with $A = 122, 123, 124$ which are shielded from r-process contributions by the stable isotopes $^{112}Sn$, $^{126}Sb$, $^{118}Sn$. Measurements of the 30 keV capture cross sections by Macklin and Gibbons (1967) gave the result

$$(N_i, \tau)_{\text{eq}} : (N_i, \tau)_{\text{eq}} = 1.0 : 1.08 : 1.04$$

confirming to $\pm 5\%$ the validity of the s-process theory.

For the two s-only isotopes of samarium, Macklin and Gibbons obtained $(N_i, \tau)_{\text{eq}} / (N_i, \tau)_{\text{eq}} = 0.98 \pm 0.06$. These results, together with those for Sr, Zr and Sn, are shown in Figure 3, and illustrate the quantitative nature of the s-process theory.

**Age of the s-process and the stellar environment.**

We have shown that neutron capture reactions at rates which are slow relative to $\beta$-decay rates (s-process) play an important role in the production of nuclei above the iron region. Of particular significance is the branch in the s-process path observed at $^{174}Lu$ (Figure 4) where $\beta$-decay of the 3.64 h isomeric state forms $^{174}Hf$, and neutron capture in the 40.8 Gy ground state leads to $^{174}Lu$ which $\beta$-decays to $^{174}Hf$ (Figure 5). Lutetium-176 is shielded from r-process contributions by $^{184}Yb$ and its abundance is determined by the decay of the long lived ground state after s-process synthesis and the population of the isomeric state. Audouze et al. (1972) derived a formalism for the determination of this age in terms of s-process quantities

$$T = \lambda_{\beta}, \text{In}[B < N_{(\text{Pb})} > / N_{(\text{Pb})}]_{\text{eq}},$$

where $\lambda_{\beta}$ is the decay constant, $B$ is the branching ratio to the ground state of $^{174}Lu$, $<N_{(\text{Pb})}>_{\text{eq}}$ is the average value of the product of s-process abundance and $30$ keV average capture cross section evaluated at $A = 176$, and $(N_i, \tau)_{\text{eq}}$ is the product for $^{174}Lu$.

Beer and Käppeler (1980) have obtained $<N_{(\text{Pb})}>_{\text{eq}} = 4.89 \pm 0.12$ (mb. Si = 10$^6$) from a weighted average of $(N_i, \tau)$ data in the 148 $< A < 186$ mass range and Allen et al. (1981a) give $(N_i, \tau)_{\text{eq}} = 1.92 \pm 0.24$ (mb. Si = 10$^6$). All quantities were known to acceptable accuracy, except $B$, which is defined as

$$B = 1 - B_{\beta} = 1 - <\sigma_{\beta} >_{\text{eq}} / <\sigma_{\beta} >_{\text{eq}}$$

where $<\sigma_{\beta} >_{\text{eq}} = 1230 \pm 130$ mb is the 30 keV neutron capture cross section of $^{174}Lu$ ($n, f$), and $<\sigma_{\beta} >_{\text{eq}}$ is the capture cross section to the isomeric state.

The isomeric capture cross section was recently measured by Beer and Käppeler (1980) at 809 $\pm 49$ mb, leading to an upper limit for the mean age of the s-process of 1 Gyr. This result was not confirmed by Allen et al. (1981a, b) who found $<\sigma_{\beta} >_{\text{eq}} = 958 \pm 58$ mb. The isomeric branching ratio is then $B_{\beta} = 0.78 \pm 0.10$. However, this new value for $B_{\beta}$ yields a negative age for s-process synthesis. An alternative and more acceptable interpretation, first suggested by Clayton (1963), is that thermalisation of the $^{174}Lu$ ground and isomeric state populations occurs in the stellar environment. The effective half life of $^{174}Lu$ is obtained from the Boltzmann equation and results from the weak population of the isomeric state in thermal equilibrium with the stellar environment.

The s-process branch at $^{174}Lu$ to $^{174}Hf$ is defined as

$$B_{\beta} = 1 - (N_i, \tau)_{\text{eq}} / (N_i, \tau)_{\text{eq}} = 0.61 \pm 0.07,$$

and is seen to be substantially less than our isomeric branching ratio. Consequently, the population of the isomeric state must be reduced significantly in less than 3.64 h to reduce the effective decay rate of $^{174}Lu$. It is unlikely that this effect could be achieved directly by photo-de-excitation, but photon inelastic scattering and Coulomb excitation processes could establish a thermal equilibrium by electromagnetic linkage to higher excited states. Enhanced decay rates could occur from Coulomb collisions with the ion plasma in the stellar environment. From analytic approximations, the resulting de-excitation rates are strongly dependent on the A and Z of the target and projectile, stellar temperature, multipole order and type and energy of the transition. For $^{174}Lu$, enhancement could occur above 4.10$^6$ K for helium burning and above 10.10$^6$ K for carbon burning. Coulomb enhancement of indirect transitions, linked through higher lying states, may prove to be even more significant than direct transitions in determining the thermal equilibrium rate.

The Australian Physicist, Vol. 19, July 1982 — Page 107
A detailed treatment of the temperature dependence of the Lu branching ratio is given by Beer et al. (1981). These authors found evidence for the effective reduction of the \(^{176}\text{Lu}\) half-life for thermal energies above 16 keV. Consequently, the \(^{176}\text{Lu}\) clock can only keep time for temperatures somewhat lower than envisaged for the s-process.

The neutron flux is established to be in the range \(2 \times 10^{13}\) to \(1 \times 10^{17}\) cm\(^{-2}\) s\(^{-1}\) (Allen et al. 1981a), on the basis of competition between \(\beta\)-decay and neutron capture rates. However, if thermal equilibrium between the ground and isomeric state is maintained after the neutron source is exhausted, all the \(^{176}\text{Lu}\) will decay to \(^{176}\text{Hf}\) in one year or so. The temperature dependence of the neutron flux and the \(^{176}\text{Lu}\) effective half-life could then result in a "freeze out" of abundances on termination of the neutron exposure.

Summary

Within fifty years of the discovery of the neutron by Chadwick (1932), the indispensable role of neutron capture reactions in stellar nucleosynthesis has been established beyond doubt. Future research in this field will emphasise the dynamics of the s-process, i.e. its time and temperature dependence. For this purpose, more accurate measurements of isomeric capture cross sections and a detailed understanding of intra-nuclear excitation and decay processes are required.

References

Lord Kelvin heard again

It is worth noting the surprising fact that a recording made by William Thomson, Lord Kelvin, exists in the British Museum. Mr P.J Weaver of Hobart, Tasmania, found a reference to the recording in a book on the history of the gramophone (From Tinfoil to Stereo by O. Read and W. Welch, Indianapolis 1959) and wrote to the Science Museum in London to ask if it still existed. After enquiries to several archives the record, a negative matrix, was located in the British Museum. It had been presented to them in May 1907 by the Gramophone Company on condition that it should not be made available until 60 years after Lord Kelvin’s death.

Lord Kelvin died in December 1907. The Science Museum borrowed the matrix and through the generosity of EMI (now Thorn-EMI) a vinyl pressing was obtained from it. On the record Lord Kelvin speaks for about three and a half minutes, reading from a paper on radioactivity which he published in the Philosophical Magazine in March 1907. He was 82 at the time of the recording, but his voice is clear and robust. He has a Scottish accent and rolls his r’s despite having spent the first eight years of his life in Belfast. His views on radioactivity from before the days of the nuclear atom are antiquated and have been forgotten. At the time, atomic physics was being revolutionised by Rutherford and his voice is a link with another age.

The records begins: ‘One chief action concerned in radioactivity is the shooting out of electrons from deesected solid or liquid bodies. In the equilibrium of kinetic averages in any solid or liquid every individual electron must occasionally have so high a velocity that it is shot out of the body. Hence every solid or liquid body has something of radioactivity’.

Kelvin was born in the reign of George IV and must be the only scientist who worked before 1850 to have left a recording of his voice for posterity.


PEOPLE

Geophysical award to Dr John Philip

The Director of the Institute of Physical Sciences, Dr John Philip, has been awarded the 1982 Robert E. Horton Medal by the American Geophysical Union. He is the first non-American scientist to receive the Medal which has been awarded four times. Dr Philip was given the award for his significant contributions to a number of fields of geophysics.

His most widely known work is pioneering development of the physical theory and mathematical analysis of the processes of water movement in unsaturated soil. Dr Philip identified and explained, for the first time, the physics of infiltration. Infiltration, the process of entry of water into the soil, plays a central part in the hydrologic cycle. It needs to be understood by everyone concerned with water: water engineers, agriculturalists, and ecologists.

Dr Philip's innovative researches led previously to his election in 1967 to the Australian Academy of Science, and in 1974 to the Royal Society of London.

— CSIRO Co-Research

New Deputy Secretary, Dept. of Science & Technology

Dr Roy Green has been appointed Deputy Secretary of the Department of Science and Technology.

He graduated in 1956 from the University of Liverpool with an honours B.Sc. in Physics. After one year on the engineering staff of Canadian Westinghouse he continued his studies at the University of Toronto, receiving his M.A. in 1958 and his Ph.D. in 1961.

Dr Green worked with the nuclear physics research group at Toronto and was engaged mainly in the measurement of radioactive sources with low specific activity, with particular application to assessment of fallout levels in the body and foods, and development of tracer techniques.

From 1961 to 1964 he was a Research Officer in the Health Physics Research Section of the Australian Atomic Energy Commission, in charge of the gamma-ray spectrometry group. He returned to Canada in April 1964 to join the Research Laboratories of RCA Limited, becoming engaged in the development of semi-conductor detectors and their application to problems in the nuclear and biophysics fields: he was appointed head of Program Development and also Director of the Optoelectronic Systems Laboratory, in which capacity he directed work in infrared and optical phenomena, lasers and electro-optical systems.

Dr Green returned to Australia at the end of 1971 as the first General Manager of WAIT-AID Ltd., a company established by the Western Australia Institute of Technology to initiate and organise research contracts and consulting studies, using the staff and facilities of the Institute. He was elected to the Board of the Company in 1974.

In April 1975 he was appointed Assistant Director, Bureau of Environmental Studies, in the Commonwealth Department of Environment, with primary responsibility for the development and management of the program of multi-disciplinary studies carried out both within the Bureau and by research institutions and consultants.

In April 1976 Dr Green joined the Secretariat of the Australian Science and Technology Council as Assistant Secretary, and was appointed Secretary in April 1977. He continued in that position until April 1982.

Dr Green is a member of the National Commission of UNESCO. He is a Fellow of the Australian Institute of Physics, and has served on several committees of the Australian Institute of Physics.

New chief for CSIRO Division of Mathematics and Statistics

Professor Terry Speed will be the new Chief of CSIRO's Division of Mathematics and Statistics. He succeeds Dr J.M. Gani, who has taken up an appointment in the US.

Professor Speed, 39, a statistician and currently Head of the Department of Mathematics in the University of W.A., joins CSIRO early next year.

Announcing the appointment Dr Wild, the chairman of CSIRO, said Professor Speed would strengthen the Division's efforts to involve itself in collaboration with other parts of CSIRO and with users of mathematics and statistics in the community at large.

"Much of his recent work is characterised by the effective and imaginative application of mathematics and statistics to real world problems," Dr Wild said.

Professor Speed's recent projects include the analysis of ocean wave data in connection with the North-West Shelf gas field, an examination of crime and imprisonment statistics, and the probability of cyclones.

Dr Wild said that in CSIRO Professor Speed intends to foster more research in the general area of signal processing, an area where, with the development of recording instruments and computers, man's information-gathering capabilities have outstripped the methods for analysing data and drawing useful inferences.

The Australian Institute of Physics Prize for the best results in the final stage of the Applied Physics degree course at the New South Wales Institute of Technology was awarded to a 1982 graduate, John Doyle, an employee of Rheem Australia, who is incorporating his work with post-graduate research on solar energy within the Department of Materials Science.

On Saturday May 15, Professor Keith D. Cole, Foundation Professor of Physics at La Trobe University, was re-elected President of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) for a further four year term. SCOSTEP is the
Committee of the International Council of Scientific Unions which coordinates international, global programmes of research on the effects of the sun on the interplanetary medium and the outer atmospheres, ionospheres and the magnetospheres of the earth and the planets. Examples of some of the problems within the ambit of SCOSTEP activities are the effects of the sun on the electromagnetic fields in the earth’s environment in space, the distribution of minor constituents (e.g. ozone and nitric oxide) in the earth’s atmosphere, the plasma in the earth’s outer atmosphere, the radiation levels in outer space and in the vicinity of communications satellites. Knowledge in these areas is becoming more important by the year to man as threats to the biosphere through pollution of the environment become reality.

Professor Cole has recently been elected as an Associate of the Royal Astronomical Society of London.

* * *

The Chairman of CSIRO, Dr J. Paul Wild, has been awarded an honorary degree of Doctor of Science by the University of Newcastle.

Dr Wild accepted the degree in recognition of his outstanding contributions to science in Australia, at the University’s graduation ceremony on April 24. He was also occasional speaker at the ceremony.

—CSIRO Co-Research

OBITUARIES

Emeritus Professor Stuart Butler

The following tribute to the late Professor Butler was presented at a meeting of the Faculty of Science of the University of Sydney on 25 May by Associate Professor Don Millar, Deputy Head of the School of Physics.

Emeritus Professor Stuart Butler died on Saturday, 15 May 1982.

Stuart Butler was born in South Australia in 1926. After a distinguished undergraduate career at the University of Adelaide he graduated with first class honours in physics in 1946 and with the degree of MSc in 1947. In 1949 he proceeded to the United Kingdom on a travelling scholarship awarded by the Australian National University. There at Birmingham University in the department headed by Rudolf Peierls subsequently a life-long friend, he commenced the work on theoretical nuclear physics with which he is internationally identified. This work concerned the interaction between a target nucleus and an incident deuteron. It was described by Stuart Butler as a 'type of stripping reaction, and the phrase was apt, describing how the deuteron as it passed by was diverted of its proton by the target nucleus. The phrase also, at any rate in 1950, produced the amused reaction which his sense of fun led him to expect.

In 1951 he obtained his PhD from Birmingham and was appointed a Research Associate at Cornell University in the U.S.A. There during the next couple of years he continued his work on theoretical nuclear physics, publishing among other papers, one with Hans Bethe, a future Nobel Laureate, and another with Ed Salpeter, a fellow Australian expatriate and sharer in Stuart Butler's sense of fun (Stripping and pick-up differential cross-sections, Butler and Salpeter, 1952).

This work was important in that it allowed one to derive from experimental observations detailed information about the states of the initial and final nuclei. This importance was formally recognised many years later, in 1977, by the award to him of the Tom W. Bonner Prize by the American Physical Society. This prize is awarded for work which contributes to nuclear physics by physicists and primarily for experimental work. This fact draws attention to Stuart Butler's approach to his own theoretical physics. He wanted it to be applicable, and of direct use to experimentalists in interpreting their observations.

In 1953 he returned to Australia to a Senior Research Fellowship at the ANU and in 1954 he was appointed Reader in Physics in the University of Sydney. Here he joined a group of young physicists assembled together by the recently appointed Head of the School of Physics, Professor Harry Messel. In what was to become the Daily Telegraph, now the Sir Frank Packer, Theoretical Department of the School of Physics, he joined forces with J.M. Blatt and M.R. Schafroth. They collaborated in work on low temperature theoretical physics, particularly on the phenomenon of superconductivity. They interacted. They sparked off each other. They recruited an enthusiastic band of research students and they built up a worldwide reputation for Sydney University's theoretical physics. This early period lasted till the end of the 1950s when John Blatt went to the University of New South Wales as Professor of Applied Mathematics and Robbie Schafroth was killed in an air accident while visiting outback Australia. In 1959 Stuart Butler was appointed Professor of Physics (Theoretical Physics) in this University and his appointment initiated the transition of the School of Physics to a multi-professorial one.

The decade of the '60s saw him continue to widen the interests of his own research and that of his students and he inspired, and shared in, work on atmospheric tides, on plasma physics and on cosmic rays as well as continuing with nuclear physics. It was no accident that these were fields of interest pursued also by the experimental physicists in the School of Physics.

Academic honours accrued. In 1961 he was awarded the degree of DSc by The Australian National University. He was invited as Visiting Professor to Cornell and to Harvard Universities. In 1966 he was awarded the Thomas Ranken Lyle Medal by the Australian Academy of Science for research carried out in the previous five years in mathematics and physics. In 1969 he was elected a Fellow of the Australian Academy of Science.

During the 1960s he undertook an ever-increasing role in the field of secondary education in the state of New South Wales, acting as chairman of many committees concerned with science and physics teaching for the Board of Senior School Studies. In the School of Physics he shared with Harry Messel the task of organising for the Science Foundation for Physics their annual International Science Schools for High School Students. He also joined Harry Messel in the organising and writing of textbooks for high school students, a task made urgently necessary by the in-
trodition of drastic changes, the Wyndham Scheme, in the education system of the State.

He was an enthusiastic believer in making science understandable to the man in the street and contributed to the popular press frequent articles, and a long-running comic-strip series, on science.

In 1970, Stuart Butler became Dean of the Faculty of Science, an office in which he served for four years. His name is to this day associated with the 'Butler index', a measure of undergraduate academic performance which he persuaded the Faculty to introduce as a means of ordering with fairness the candidates for postgraduate scholarship awards. First as Dean, later by election, he was a Fellow of the University Senate from 1970 to 1977 and again from 1979 until his death. He was Deputy Chairman of the Academic Board from 1975 to 1977.

In 1977 he resigned from the University when he was appointed Head of the Nuclear Science and Technology Branch of the Australian Atomic Energy Commission at Lucas Heights. The University bestowed upon him the title of Emeritus Professor. The Senate also, on the recommendation of the Faculty of Science, appointed him a member of that Faculty and that membership was recently renewed. In this way, and that, it is pleasant to note, during his lifetime, the University honoured his great and distinguished contribution to its work.

Despite these honours and the fame as an outstanding scientist which he enjoyed, he remained a generous and friendly man. In his work he was never competitive with colleagues. Competitiveness there was, but expressed lightheartedly — in his earlier years in athletic pursuits (Indian-wrestling for one) and in later years by his prowess when trout fishing at Lake Eucumbene. He enjoyed life and communicated that enjoyment to all who knew him. Sharing that life and contributing most to that enjoyment was his wife Miriam. To her and to their children we convey our condolences and our appreciation of all that he did as a member of this Faculty.

— University of Sydney News

Dr. Walter M. Boas

Dr. Walter Boas, one of Australia’s most highly respected scientists, died suddenly in Melbourne on Tuesday, May 12, aged 78. He leaves a wife, daughter and son.

Internationally known and recognised for his work on the physics of metals and their behaviour under stress and deformation, Dr. Boas was the author of numerous books and specialised papers on the subject as well as one of the pioneers of the scientific study of engineering materials.

For 20 years, before his retirement in 1969, he was Chief of the CSIRO Division of Tribophysics where he was “father” to a hand-picked group of Australia’s most promising young scientists, many of whom rose to great distinction under his guidance.

Walter Boas was born in Berlin in 1904 and received his doctorate from the Technical University there in 1930. Having established his scientific reputation in various universities and research institutions in Germany and Switzerland, he came to Melbourne University in 1938 as Carnegie Lecturer, and later Senior Lecturer, in Metallurgy. During the war years, he worked in close collaboration with the CSIRO section of Bearings and Lubricants, which later became the Division of Tribophysics and which he joined in 1947 as Principal Research Officer. He was appointed Chief of Division in 1949. Under his leadership, the Division broadened its work and carried out highly successful and distinguished research into the properties of materials and of solid surfaces. He was elected Fellow of the Australian Academy of Science in 1954; was Foundation Member and President of the Australian Institute of Metals, Honorary Fellow of the Australian Institute of Physics, Foreign Scientific Fellow of the Max Planck Institute for Metallurgical Research in Germany and was honoured by numerous other learned societies both here and overseas.

After his retirement from the CSIRO he became Honorary Fellow in the Department of Metallurgy at Melbourne University as well as Chairman and Vice-President of the International Union of Pure and Applied Physics.

His position as senior statesman in the world of science and as friend and advisor to his colleagues continued to the very end. Boundless enthusiasm and irrepressible good humour were the main attributes of this lovable and humane man who will be sadly missed by his numerous colleagues, friends and students. There will be no one left to tell them firsthand what Planck said to Einstein after the lecture by Schroedinger.

LETTER

The Asian Physics Education Netword (ASPEN), which was established in cooperation with UNESCO earlier this year, intends to produce a Network Newsletter. They would welcome contributions with relevance to the Asian Physics Community from Australian physicists. Such contributions could take the form of short reports on, or announcements of, conferences and seminars in either physics education or research. They would also welcome special reports highlighting facilities and courses for physics education and/or research in Australia, and short papers on physics education topics.

Physicists interested in contributing to the Newsletter should contact either:

Dr. S.C. Lim,
Physics Department,
Universiti Kebangsaan Malaysia,
BANGI, Selangor,
MALAYSIA

Dr. Margaret Mazzoline
(Chairperson, ASPEN),
School of Physics,
UNIVERSITY OF MELBOURNE

The Australian Physicist, Vol. 19, July 1982 — Page 112
Awards encourage excellence in Physics students

Cheques ranging in value from five to seven hundred dollars were presented to fourteen physics undergraduates by the Chancellor of the University of Sydney, Sir Hermann Black, at an informal gathering at the School of Physics last Wednesday, 2 June.

Five students were awarded $500, another five $600, and a further four $700, in recognition of their excellent academic performance in Physics I, II and III respectively. They were the first students to win what will be an annual award, to be known as the Science Foundation for Physics Awards for Excellence.

The Head of the School of Physics, Professor Harry Messel, said that the most practical way he could think of to honour excellence was to pay it.

Professor Messel said the Science Foundation had for many years honoured excellence in high school students by giving the top students the opportunity to participate in the Science School, and had honoured excellence in staff and postgraduates by supporting their research.

‘After 25 years, we took a close look at what was going on and decided that we should also honour excellence in a practical way among our undergraduates’, he said.

—University of Sydney News

Anzac Fellowship scheme

New Zealand awards

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

This is not an academic competition, and Fellowships are not normally available to members of the academic staff of institutions of higher education for the purpose of furthering their academic studies.

- Awards are tenable for periods of a minimum of three months and a maximum of one year and must be commenced in the calendar year for which they are available.
- Candidates must be Australian citizens and preferably under the age of 45 years.
- A Fellow should reside in Australia on the expiry of the Fellowship.
- A Fellow is required to submit to the New Zealand authorities a report on the program undertaken the Fellowship.

Benefits include a maintenance allowance at the rate of $NZ12,045 per annum, and economy return air fares for the Fellow from the airport nearest his home in Australia.

Application forms may be obtained from: The Secretary, Department of Education, (ANZAC Fellowship Scheme), P.O. Box 826, Woden, A.C.T. 2606. The closing date is 6 August 1982. Late applications will not normally be accepted.

Satellite weather-watch

The tiny sand cave of Marion Reef and Lihou Reef, 500km east of Townsville in the Coral Sea, are part of the network of unmanned automatic weather stations that guard Australia’s northern coastline.

Every three hours, information on existing weather conditions is transmitted to the mainland and used in the preparation of the daily forecasts and warnings issued by the Bureau of Meteorology.

It’s a system that has worked well since the first stations were installed in the 1960s, particularly during the summer months where destructive tropical cyclones develop in the Coral Sea, the Arafura Sea, and the Indian Ocean.

However, Marion and Lihou Reefs have now been given additional weapons in their defences against the cyclone threat.

Late last year Bureau engineers installed new equipment that provides another means of obtaining meteorological data from the sensors that measure atmospheric pressure, temperature, wind speed and direction.

Eight times a day, data from the two stations is now flashed to two American weather satellites as they pass overhead, 800 km out in space.

As the satellites continue to their polar orbit, the data stream is transmitted to a Bureau receiving installation at Rockbank, just outside Melbourne.

From there the information is sent to the Bureau’s Head Office where a telemetry decoder extracts the information required by the meteorologist.

The new equipment, known as Data Collection Platform, has been developed as an economical back-up system that will supplement the operation of the existing installations on the Marion and Lihou stations.

Because maintenance on the remote stations is

Supporting companies

The following organisations are Supporting Companies of the Australian Institute of Physics (they are called Company Subscribers in the Articles of Association). Supporting Companies pay an annual subscription and nominated people in the company receive the Australian Physicist. The Institute is grateful for the support and interest of these companies.

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The Australian Physicist, Vol. 19, July 1983 — Page 113
Solar ponds may light up the far outback

A hole in the ground, a bottle of Indian ink, and a set of specially-designed honeycomb grids are the base ingredients of an outback power source planned by solar energy researchers at the University of Queensland. The scheme is being developed by a team from the University’s Solar Energy Research Centre (SERC), under the direction of Dr Ugor Ortabasi and chief investigators Dr Narendra Kauhik and Mr Frank Dyksterhuis.

The basis of the power source is a large shallow pond filled with water, covered with a layer of oil and transparent honeycomb grid structure to maximise heat absorption the water is inked black or the base of the pond darkened. This system, the researchers have discovered, produces temperatures in lower water levels of between 80 and 85°C. The heated water can be drawn off, from a pond of around 500 square metres, and used to run steam turbines capable of generating at least five kilowatts of electricity. This amount could supply the power needs of most outback homesteads.

Although the solar pond concept is not new — one in Alice Springs provides power for large commercial users — the University of Queensland variation is unusual in that it uses honeycomb grids in conjunction with oil. The grids, suspended in the surface oil layer, reduce temperature loss and water instability caused by wind disturbance.

The SERC system also dispenses with the need for salt in the pond water, which has caused problems for solar researchers throughout the world. Other solar ponds use concentrations of salt which increase with depth to trap heat at lower levels.

Solar ponds have long been recognised as a relatively cheap, simple way to produce energy. The biggest problem is the maintenance of the complicated saline gradient — too much salt at higher levels will cause the system to function ineffectively. Concerns over the possibility of environmental contamination associated with its use are others which must be taken into account.

By eliminating salt from the system SERC has overcome these problems, and through the use of oil and floating honeycomb grid have solved those of evaporation, bacterial contamination and convection currents caused by wind disturbance.

The University of Queensland team believes the use of transparent perspex in a honeycomb grid configuration on the surface of its ponds is a key element — cutting out wind disturbance, and acting as a heat “trap” or insulating cover.

For the grids to be fully effective, the SERC team must now establish the optimum depth of the surface layer of oil.

The oil, Mr Dyksterhuis said, will have several important functions.

“It will act as a sealing agent to help prevent bacterial and other contamination of the fresh water, it will negate evaporation, and most importantly, act as an insulating agent and further cut down convection losses in conjunction with the grids.”

“We must now find out how much oil and what type, will best do the job.”

To get these answers the team is now putting the finishing touches to two experimental ponds in the grounds of the University of Queensland’s Solar Energy Research Centre.

Trials to establish the system’s effectiveness will be underway within one month, with researchers confident of a firm data base for commercial application within 12 months.

Mr Dyksterhuis said the system could have wide application in remote areas where electricity from the state power grid was unavailable.

“Our system will have several attractions over more traditional power sources in the outback.

“It will be virtually maintenance free (providing it is not placed close to trees or other foliage) and will be simple to establish.

“Few graziers will baulk at digging a big, shallow hole in the ground, and even fewer at a cost figure which will probably be less than that currently charged for connection to the state power grid in remote areas.”

University of Queensland News

New Wind-Powered Generator for Army

Engineers of the Defence Science and Technology Organisation are developing a new type of wind-powered electricity generator with potential for use by the Army. It could meet the Army’s need for a transportable generator to power field signals equipment. The system needs no fuel, can easily be dismantled and is reliable enough to operate unattended for several months at a time.

The new equipment is based on the Darrieus turbine, a design which uses upright vanes moving in a circular path about a vertical axis. The vertical blade system does not require turning into the wind like multi-blade or propeller-driven generators and operates generating equipment which can be located at ground level for easy access.

Designed by two mechanical engineers, Mr M.L. Robinson and Mr W.R. Crook, at the Defence Research Centre at Salisbury, South Australia, the equipment can provide enough electricity for a small Army field communications centre. The turbine, measuring 3.7 by 3.7 metres, can be dismantled easily and carried in a truck.

Mr Robinson, who works for the Weapons Systems Research Laboratory and whose speciality is aerodynamics, applied existing aerodynamic theories to the Darrieus type of wind turbine and predicted its performance in various wind conditions.

His research provided the data for his colleague, Mr Crook, of the Advanced Engineering Laboratory, to design a turbine power generating system to function with an output of one kilowatt at wind speeds about 15 knots.
AEL apprentices contributed by building a demonstration model for evaluation.

An average output of one kilowatt is sufficient for the Army's field signals needs, and is the same as that used by Telecom to power its microwave repeater stations.

A typical outback household uses an average power of 0.8 kilowatts, and a capital city household averages between 1.5 and 2 kilowatts, excluding heating. The DRCS design would therefore be useful both on farms and to serve communications repeater stations in remote areas. The State Governments of South Australia and Tasmania have expressed interest in the turbine concept.

The turbine's blades are made of aluminium alloy to conform precisely to aerodynamic requirements and to provide a high stiffness-to-weight ratio. They cost only $30 each, greatly reducing the overall cost of the equipment which if manufactured in quantity should compete well with established propeller-type wind generators.

Although the Darrieus wind turbine concept, the brainchild of a French inventor of that name, is more than 50 years old, the equipment developed in South Australia includes many refinements and advances over the original design.

The alternator and the electrical control, still in development, are technologically advanced. The alternator is of special design for low speed operation and direct coupling to the turbine. The control is based on a micro-processor to ensure high system efficiency.

Both Mr Robinson and Mr Crook are graduates of the University of Adelaide's School of Mechanical Engineering.

Two DRCS employees, Mr Ralph Crook, engineer in charge of mechanical design, and Mr Frank Wade, information officer, inspect the new wind-powered electricity generator. The generator puts out an average power of one kilowatt and, when completed, will be able to produce a peak power output of 4.6 kilowatts at 300 r.p.m.

**BRANCH ACTIVITIES: Victoria**

Detailed research seminars have become the domain of university, CSIRO and other research laboratories; AIP monthly meetings are increasingly being devoted to more general topics with wider appeal. This audience preference was unambiguously demonstrated in the first two regular monthly meetings of the Victorian Branch for 1982, devoted to 'Sound production and hearing in some simple animals - a physicist's view' and 'Images - a demonstration lecture' and attended by the largest Melbourne audiences for some time.

The lecturers, Professor Neville Fletcher (University of New England) and Professor Charles Taylor (University College, Cardiff and the Royal Institution, London) have much in common. Physically very similar (both tall, with a good shock of swept back hair), they established outstanding reputations for research work in traditional areas of physics and then branched out into less-common byways of the subject, both moving into acoustics and the science of musical instruments and both taking a serious interest in science education and the popularisation of physics, Professor Taylor through the Royal Institution, the British Council and BBC-TV. Their talks equally captivated the Melbourne audiences.

Professor Fletcher examined sound production and hearing in insects and frogs, beginning with a tape recording of the pulsating, scratching noise of the cicada; a noise that can become ear-splitting and brain numbing if enough cicadas are in the vicinity. As with humans, the motive was communication, principally regarding territory and mating for the insects.

Professor Fletcher sketched the characteristics of the human voice and hearing system: the frequency spectrum of the voice, the role of the vocal folds, tongue, lips and mouth and throat cavity, the time resolution required and the sensitivity of the auditory system. The song of the frog and its production mechanism were much simpler, but by no means trivial; the croak has a 2kHz carrier wave modulated by a 40Hz component, a waveform that Professor Fletcher has measured and synthesized effectively.

Many of his insect and frog sounds had been recorded in his Armidale garden he told us: do we have a real but unheralded Dr Doolittle in our midst?

Spectral analysis of the cricket sound revealed two major components due to the forward and back stroke of the rapid scraping of its wing covers. Such a mechanism does not of itself produce a loud sound; like many insects the cricket uses forced ventilation of its body and some cunning anatomical tricks to form a very efficient resonator and a resultant sound intensity in the 80db range.

The male cicada Professor Fletcher described as a big, clumsy bag of wind, who did, however, have sufficient common sense to sing only at dusk when the daytime birds had stopped hunting and the night time predators were not yet about. Their sound was produced by a tymbal mechanism, movement in and out of the concertina folds in the cicada's tough skin. Because the size of the insect's wind bag was less than one wavelength of its sound note, its radiative efficiency was poor - 100mW of input power being required to produce a 5mW output.

The speaker then outlined one particularly
interesting hearing mechanism, that of the caterpillar. Thin, pointed hairs on the caterpillar's body were ideally designed (length 0.5mm) to detect the velocity field (rather than the pressure field) of the air emanating from the 150Hz wing beat of its natural predator, the wasp. A caterpillar living on the underside of a leaf could then release its grip and fall to possible survival!

Professor Fletcher devoted the remainder of his address to the modelling of these systems in terms of A.C. circuit theory; voltage representing the sound air pressure, current the air flow, resistance the resistance of the insect's anatomy and the air itself to air movement, capacitance the elasticity of the insect and its air cavities and inductance the mass of the various air volumes involved. Resonance frequencies and sound intensity and frequency distribution patterns were faithfully reproduced by this method of analysis, both for the sound production and hearing processes. The anatomy of the animal is clearly central to the establishment of the appropriate analogous circuit, and explanations of how an insect determines the direction of arrival of sound; how it can listen while itself singing (by alternatively disconnecting and opening its ears); how a frog avoids getting food all over its inner ears, which open straight into its mouth (it flicks the flies straight down its throat); and why the cricket has its ears on its elbows and knees were thus provided.

Such a talk renews one's faith in the breadth and humanity of physics.

Professor Charles Taylor was in Australia as a guest of the Australian Academy of Science; in Melbourne he gave talks on science education, sound and acoustics and, for the AIP, imaging. Although the diffraction of electromagnetic waves, musical acoustics and other imaging processes were united by the Fourier transformation, Professor Taylor made no apology for presenting a lecture on the teaching of diffraction and image formation which included copious demonstrations and no mathematics. Despite the apparent simplicity of the material and of the approach, it is hard to believe that a single member of the full-house audience went home disappointed.

Having plunged the theatre into darkness to emphasise the importance of vision as a mechanism for the exchange of information, Professor Taylor began with a 35mm slide projector containing a simple slide (with a large cross) but without its focussing lens. The resulting large patch of diffuse light was a hologram, the lecturer pointed out, each point on the screen receiving light from the whole of the object plane. This he startlingly demonstrated by holding up a small lens in front of various parts on the screen, when a clear image of the object cross appeared. Imaging, he pointed out, involved the interaction of light with the object and then rearrangement of the resulting information to produce an image; a process of separation and recombination, coding and decoding or diffraction and focussing.

Focussing, it was emphasised, was far from trivial. How did you decide, for example, if the image was in focus if you didn't know what the object looked like? This was an area where biologists had got into some difficulties with electron microscopy and where the physicist with a knowledge of imaging techniques could provide assistance.

The lecturer then introduced his next simple but powerful demonstration - a 12 inch rule with holes drilled all along one edge and a 3 foot striped string with small hooks at each end. Connected to the extremities of the rule and with the stripes representing crests and troughs, the extended string immediately gave a vivid representation of the regions of reinforcement and cancellation in the diffraction image of a double slit. By reducing the separation of the slits (ends of the string) the loss of information when this distance was less than one wavelength or when the aperture of the instrument was too small was equally well demonstrated.

The advantages to be gained by the use of coherent laser light provided the theme for the pièce de résistance of the evening: Professor Taylor's portable, suit-case diffractometer. Laser light illuminated a variety of prepared 35mm-slide objects, the resulting light passing through two small lenses and appearing as a reconstituted image on a ground-glass screen, from where it was projected by closed-circuit television to the audience. The diffraction pattern was also easily shown by removing the second lens. All optical elements were mounted on small but solid bases which the lecturer manipulated with practised precision. The secret of this varied demonstration lay perhaps in the prior preparation by photographic reduction of transparent objects on otherwise opaque 35mm slides. Thus a 'man' wearing a striped uniform could be imaged without the stripes by simply removing with a small slit (made from two razor blades) all but the central element of the diffraction pattern. The diffraction pattern of a helix (that now famous X-ray diffraction example) was similarly demonstrated, thus calling attention to the problems of deducing the structure of an object when there is no mechanism for recombing the diffraction pattern into a direct image.

Professor Taylor also discussed scanning, ultrasound, infrared and radar imaging as practical examples of the central importance of wavelength in these discussions.

Much of this fascinating material is to be found in a book that deserves to be better known in Australia; namely, 'Images' by C.A. Taylor, Wykeham Science Series, available in this country from the Australia and New Zealand Book Company. Teachers of optics and light diffraction and crystallography and like subjects, and research workers in these fields should surely have a copy on their shelves, for they too can then share some of the magic that the Melbourne audience experienced. We, however, were privileged to hear it live and to capture some of the essence of a Royal Institution lecture in the spirit of Faraday, Tyndall and the Braggs. For a lecturer there can surely be no greater challenge and no greater accolade than this.

John Jenkin
La Trobe University
BOOK REVIEWS


Reviewed by P. Mulhearn, with contributions from D. Cato and W.F. Hunter, R.A.N. Research Laboratory, Edgecliff, N.S.W.

In this monograph the authors are primarily concerned with the effects of internal gravity waves on long-range sound transmission through the ocean using ray theory and extensions of ray theory. As such it is a book for the specialist in underwater acoustics, or for the physical oceanographer who wishes to use acoustics as a tool for studying internal waves, and provides survey of work performed in this area.

Although the emphasis in this book is on internal waves, Part I gives a valuable overview of ocean structure and of the various fluctuations within it. For someone unfamiliar with oceanography parts of this may be too condensed to be readily understood, but references are provided for those who require them.

Part II describes the ocean sound channel and introduces the wave equation. There is a very interesting account of angle-depth diagrams which are new to the reviewers, but which are an excellent technique for presenting a great deal of information in a compact form.

With Part III the main part of the book begins. Transmission through a statistically homogeneous, isotropic medium is discussed first. The real ocean is not homogeneous or isotropic however, having a sound-speed which varies with depth and internal wave fluctuations whose characteristics are also very depth dependent. Part III therefore goes on to generalise its treatment of sound transmission to include these two important effects. In this part the main results are summarised and discussed, while derivation of the results is presented in Part IV.

The book concludes with a detailed account in Part V of some recent experiments examining temporal fluctuations in sound transmission. Agreement with theory is satisfactory in most cases, but tidal oscillations appear to be important in some situations.

The book is generally well written and the mathematics well presented except that in some instances cross referencing of equations is inadequate. It complements rather than replaces existing textbooks on underwater acoustics.


Mössbauer spectroscopists will be familiar with the nine-volume "Mössbauer Effect Data Index" covering the literature from 1966 to 1976 and identifying it by six-character reference codes. The "Cumulative Index" aims to complete this series by providing three indices (comprising lists of the same codes) referenced by Mössbauer isotope, which could with advantage, have been listed on the first page. The author index takes up 85% of the volume. Workers who undertake literature searches and have access to the "Mössbauer Effect Data Index" would find the "Cumulative Index" a valuable aid.

EXTENDED BOOK REVIEW:


An extended review by G.C. Lowenthal, Coffs Park, N.S.W.

Older members of the New South Wales Branch of the Institute of Physics will remember Dr Ilse Rosenthal-Schneider from meetings during the 1940s and 1950s, when she and her husband attended whenever speakers discussed the theory of relativity, but not only then. Other members were her students. She lectured for several Departments of the University of Sydney but never sought a permanent appointment. Early in 1944, Einstein learned that the University of Sydney might establish a permanent lectureship on the philosophy of science, he wrote to her at once that he wanted to support her candidature, enclosing a testimonial "... she has well-founded knowledge in these matters and is independent and original in her views and opinion". But she would not apply for any position and the University made no move to offer her a post — something rarely if ever done here but the only method for making University appointments known to her from pre-war German practice.

That Einstein had judged Dr Rosenthal-Schneider's abilities correctly, will be confirmed by all readers of this book. It would also be confirmed by anyone who, like this reviewer, had the good fortune to be invited to her home to talk about her experiences in this country. She is now over 90 years old, but by any standard her analytical powers remain exceptionally high. She lives in a small house overlooking Sydney harbour. It is the same house she and her family first occupied on arriving in this country.

The book under review is slim, comprising some 150 openly printed pages. The six chapters of discussions and correspondence on reality and scientific truth occupy some 90 pages, including several pages for photographs and facsimiles of letters. This is followed by a 33-page appendix on Eddington's philosophy of science and preceded by two forewords. The first was written by Dr A.I. Miller, Professor of Physics at Harvard University, the second by Th. Braun, Dean of Merton College of the

The Australian Physicist, Vol. 19, July 1982 — Page 117
University of Oxford. Professor Miller recently completed a book on Einstein’s special theory of relativity and he offers a concise and very helpful account of the advances in classical and later in quantum physics from the late 19th century onwards. These advances provided the background and some of the subject matter of the present discussions. Th. Braun is the editor of this book. His brief foreword records a few biographical facts about the author and the three physicists who were dominant figures at Berlin University during her undergraduate and post-graduate studies. He also gives a few vignettes of the fateful happenings of the 1930’s.

Controversies on reality and scientific truth continue to this day. They have filled many volumes and will fill many more. This series of “charming letters and recollections” (New York Times Book Review 19-7-81) was not written to contribute to the resolution of the controversies but to bring home to readers the intensely personal nature of many of the resultant conflicts. They were inner conflicts fought out within each man’s soul generated by tradition, conscience and expanding knowledge. The issues were the maintenance of “faith in rational and comprehensible laws of nature” (Planck) and of an “all-pervading compelling causality for all physical processes” (Einstein).

The book’s qualities show clearly in the style and thoughtfulness of the writing and in the subjects selected for discussion to which I shall turn presently. Ilse Schneider’s experience, while still a 15-year old high school pupil, is revealing. Not many 15-year old girls, or boys for that matter, are fascinated by the discovery that analytical geometry succeeds in uniting two completely separate fields of mathematics. That the young school girl was fascinated by this discovery and spent many hours discussing it with her father and teachers can be recognised, in retrospect, as a significant pointer to her intellectual attainments.

When ruthless persecutions by the Nazi government forced the Rosenthals to leave their homeland (Fleming and Baily 1969), they were in their 40s. Dr. Rosenthal was a noted electrical engineer who soon became a corporate member of the Institution of Engineers. He practised as a consultant engineer until his death in 1968, and the present book is dedicated to his memory. Dr. Ilse Rosenthal-Schneider had closely co-operated with many of the best-known physicists and philosophers of her time and she and her husband were dignified representatives of that rarey-with cultural traditions which combines high intellectual attainments with a noble and self-effacing character. Already in 1921, she had published a book on “The Space-time Problem with Kant and Einstein”, a project which had been the subject of her doctoral thesis. Later she was to be invited to contribute to the “Library of Living Philosophers” (Rosenthal-Schneider 1949).

Dr Ilse Rosenthal-Schneider and her husband were members of the Australian National Research Council until this Council ceased to function after the establishment of the Australian Academy of Science. She soon became affiliated with the University of Sydney and lectured mainly for the Department of German and for the University Extension Board on whose behalf she undertook very successful tours to all important country towns in New South Wales. Her subjects covered a wide range from the fields of the history and philosophy of science and included discussions on outstanding personalities, for example, Kant and Leonardo da Vinci. All these subjects were still listed in the 1975 syllabus of the University Extension Board. Actually, following her husband’s death in 1968, she retired more and more from public activities and concentrated her efforts on bringing together the materials for the present book.

I have written about Dr. Rosenthal-Schneider at more length than is customary in book reviews because her activities in this country, including the correspondence she conducted, and a part of which is reproduced in her book, form direct links between Australia and a number of great scientists whose names stand for an epoch in European science. Australians with interests in these fields will receive through her book direct evidence of the intense personal involvement which these matters generated among outstanding European scientists and which I referred to above. Science was to them more than just a matter of obtaining sound and reliable results about natural phenomena and the relationships between these phenomena; these results must, of course, be a primary concern with every practising scientist. But there is also the symbolic relationship between knowledge gained through scientific advances on the one hand, and certain philosophical issues on the other hand. Here these issues revolve about the ability — or perhaps the inability — of scientific advances to reveal knowledge about an enduring physical reality and about the nature of man’s place within that reality. In keeping these matters firmly in their sights, the three scientists retained conscious not only of the powers of man’s imaginative insights when guided by his reason, but also of intrinsic limitations to these powers.

On enrolling at Berlin University, Dr. Rosenthal-Schneider entered an intellectual environment highly favourable to work in theoretical physics which had been strongly stimulated by a series of revolutionary discoveries beginning with that of X-rays by Roentgen in 1895. We are, to quote from Professor Miller’s foreword, “fortunate that she decided to set in writing her reminiscences of Berlin, and to publish copies of her correspondence with Einstein, von Laue and Planck because her book enlarges our knowledge of these man as scientists and as human beings”.

She studied philosophy and theoretical physics, two disciplines then closely allied in German Universities, and she was strongly influenced by Kant’s teachings on the nature of physical reality. These teachings and subsequent developments (neo-Kantian teachings) permeated German academic life and exerted a strong influence not only on the study of philosophy but also on developments in theoretical physics. That Miss Ilse Schneider, as she then was, communicated so naturally and easily with men considerably her seniors in every respect is no doubt a consequence of accepting similar values and similar ways of looking at the world around them. This is evident from the accounts of personal exchanges before Dr. Rosenthal-Schneider’s emigration from Germany and in subsequent correspondence.

There are four subjects selected for closer discussion in the book: the universal constants of nature, the concepts of substance and conservation, the concept of physical reality and the smallest length. These discussions are rounded out in a subsequent chapter containing more comments on the
philosophies and personalities of the three famous physicists. This appears to be an excellent selection but the treatment is unavoidably fragmentary. Issues and problems are raised and essential points are highlighted but there is little development. Still, the book is not a text but a series of recollections which are presented cogently and clearly. Readers with sufficient command of the German language will enjoy the masterly style of the letters and particularly those of Einstein, as well as their courteous and considerate tone, a style of writing which could be revived to advantage in our days. All letters written in German are followed by translations into English.

It was, with few exceptions, Dr. Rosenthal-Schneider's perceptive questioning which started the ball rolling and kept it rolling. Universal constants or physical realities are all reasonably unambiguous concepts, certainly at a first glance. But the nature of the relationships between them is another matter, and this is shown to hide a plethora of complexities and doubts even for men like Einstein.

But it is physical reality and in particular the status of determinism and strict causality which stand at the centre of all these discussions. All participants were far too competent as physicists not to recognize the superior explanatory power of quantum physics over that of all rivals, especially after Bohr's triumph in the interpretation of the Einstein-Podolsky-Rosen Paradox. (Einstein et al 1935).

But the three physicists firmly refused to accept this situation as more than transitory. When Einstein agreed that: "this (quantum) theory is, until now, the only one which unites the corpuscular and undulatory dual character of matter in a logically satisfactory fashion" (Schlegel 1967), the accent was firmly on the words "until now".

Since Einstein made this statement, the quantum theory has continued to meet all challenges and its predictions could be made with sufficient accuracy to remain well within experimentally attained uncertainties (Bell 1964). Dr. Rosenthal-Schneider accepts this, but she clearly endorses implicitly and explicitly Einstein's often quoted rejoinder that "if it should be possible to move forward to a complete description" — he does not accept quantum theory as a complete description — "it is likely that the laws would then represent relations among all the conceptual elements of this description which, per se, have nothing to do with statistics" (Schlegel 1967). Meanwhile, neither she nor the three scientist-philosophers from whose correspondence she quotes, are prepared to accept a theory as representing scientific truth if it can predict "that waves from a light source will give rise to photon interactions on an appropriately placed photographic plate but there is nothing in the theory, except a probability estimate, that corresponds to the specific localising of the photon interaction ... or to the process of transition from a wave to the corpuscular photon" (Schlegel 1967).

Planck, Einstein and von Laue carried their refusal to accept the statistical interpretation of physical reality to their graves. Dr. Rosenthal-Schneider assures us in her book that she remains to this day in complete agreement with her late collaborators. Many will be tempted to shrug off such attitudes as ingrained conservatism seeking in vain to block the path of progress. But this could be an over-hasty conclusion. In the realm of the very small, classical physics with its uncompromising determinism failed to gain experimental confirmation of its predictions. But these conditions are, in practice, infinitely far removed from normal human experience. It now appears that scientists who are strongly philosophically-minded are unwilling to forgo at least a minimum of conformity with normal human experience where every effect has a cause and no cause remains without effect. To maintain trust in the validity of normal human experience may be inappropriate for contemporary quantum physics. But then, philosophers want to account for human experience as a whole and not only for a part of it.

The appendix is a review of Eddington's contributions to the philosophy of the physical sciences. It is here that Dr. Rosenthal-Schneider shows her powers of analysis, especially in her comparisons of Eddington's view of physical reality with those of her first teacher, Emmanuel Kant, and also with the schemes of classical and quantum physics to which Eddington made so many important and often delightfully witty contributions.

Ilsa Rosenthal-Schneider through her interactions with three of the truly great physicists of modern times brings Australia right into a very human chapter of the history of science. We are shown not only the strength of character and intellect displayed by all four protagonists in this story, but there is also a sense of uniqueness: it is highly unlikely that anyone else in this country had opportunities enabling him or her to add to this book or to provide similar material.

The book will provide stimulating reading to anyone with a philosophical bent and especially to those having some general familiarity with the chosen subjects since they would not be unduly worried by the fragmentary nature of the discussions. Even though physicists who are firmly convinced and apparently on good grounds — that these arguments have been conclusively settled once and for all, may find it useful to spare an hour to review them. If the four dramatis personae in this book went wrong with some of their theories and interpretations of reality, the values they defended certainly remain valid and so does their faith in the validity of every-day experience, as verified by carefully made and thoughtfully checked observations.

REFERENCES

Bell, J.S. (1964). "On the Problem of Hidden Variables in Quantum Mechanics", SCAC — PUB — 44; see also "Bell's Theorem — Physics and Reality", Talk on ABC Science Show (June 1980) by Professor B. McCusker, School of Physics, University of Sydney (unpublished).


The Australian Physicist, Vol. 19, July 1982 — Page 119
Welcome

Professor W.A. Runciman
Chairman of the Organising Committee.

On behalf of the Organising Committee I have pleasure in welcoming you to the AIP Fifth National Physics Congress. In planning the Congress we have aimed to provide a program of invited lectures which are of general interest and which do not compete with the specialist conferences also held under the auspices of the AIP. For the most part parallel sessions have been avoided in order to encourage the interaction of physicists with a great variety of backgrounds.

The Congress has received generous support from the Australian Development Assistance Bureau and the British Council. It is through the former that it has been possible to extend invitations to a number of Asian physicists to participate in the Congress. I hope that this will prove to be a forerunner for regional conferences involving, for example, the recently formed Asian Physical Society.

The Congress will be opened by Sir Mark Oliphant, A.C., K.B.E., F.R.S., F.A.A. who is especially well known in Canberra since he was the first Director of the Research School of Physical Sciences from 1950-63 and has retired to Canberra after being Governor of South Australia from 1971-76. Professor Ramachandra Rao, until recently Vice-Chairman of the University Grants Commission in New Delhi, will address a few remarks as one of our invited Asian speakers. The opening address will be delivered by Professor Peter Karmel, recently appointed Vice-Chancellor of the Australian National University.

Morning sessions will be devoted to scientific sessions featuring invited speakers. In the afternoons, there are poster sessions, visits to Questacon and some workshops which will allow considerable time for discussion. I hope that you will enjoy these more informal sessions which will depend on the contributions from participants for their success. Professor Neville Fletcher, F.A.A., Chairman of the AIP will provide closing comments. The Organising Committee looks forward to meeting you during the Congress.

AIP FIFTH National Congress
23 — 27 August, 1982
Australian National University

Welcome

Peter Karmel
Vice-Chancellor
Australian National University

I am pleased to welcome you to the AIP Fifth National Physics Congress to the campus of the Australian National University. Physics has played a prominent role at the ANU from its earliest days of the University. The Research School of Physical Sciences was one of the first four Schools comprising what is now known as the Institute of Advanced Studies. Appropriately, your Congress is to be opened by Sir Mark Oliphant, the first Director of the School. The majority of your sessions will be held in the Leonard Hasley Lecture Theatre, named after one of my predecessors, himself a distinguished physicist.

On this first occasion that the Congress has come to the national capital, the focal point for Australia's formal international scientific links, it is appropriate that, when planning this Congress, the organizers should have looked outside Australia to their colleagues in Asian Countries. I am delighted that some have been able to accept an invitation to attend the Congress and to participate in the symposia which make up the program.

To all our visitors from overseas and from within Australia, I extend a warm welcome on behalf of the ANU. I look forward to greeting you at the opening ceremony and wish the Congress every success.

Welcome

Dr O.J. Raymond, Chairman, ACT Branch, AIP.

On behalf of the members of the Australian Capital Territory Branch, welcome to the AIP Fifth National Physics Congress. As can be seen from the accompanying program, the various Sessions and Workshops of the Congress cover a range of topics of wide interest and each important to the development of future directions for Physics in Australia. The Congress proceedings will have significant implications for the future of Australia itself through education, research, technology and other basic aspects of the life of this country and of its regional neighbours. It service just two ways in which this will happen.

Among the topics for discussion under Physics Education and Training will be the question of what project or projects should next be suggested to the Australian Academy of Science in support of the biologists' "Web of Life" and the importance of good physics education at all levels, this topic will be of great interest to many, especially to physicists, including physics teachers.

Last year, the National Committee for Physics of the Academy of Science prepared a report on Physics in Australia, reviewing physics activities in this country. It was published earlier this year. During the Session on Physics in Australia, Past and Future, Professor Angus Hurst (Chairman of the National Committee) will raise for discussion many of questions this report raises for the future development of physics in Australia. Clearly, in this way and many others Congress will provide you with a rare opportunity of contributing your ideas and views on this very important subject in a major national forum.

The Congress Organizing Committee has made a special and very successful effort to attract the Congress many noted overseas speakers — from America, Britain and particularly from our Asian neighbours. Together with the many prominent Australian speakers, they offer a program of great and wide attraction.

The Royal Australian Chemical Institute is holding its Seventh National Convention at the ANU at the same time as our Congress. There will, therefore, be opportunities for interaction between the two disciplines, including joint activities and arrangements as set out in the Congress brochure.

While in Canberra, I hope you will take the opportunity to visit some of the many places of interest in and around the national capital. Especially I recommend a visit to the Questacon, the thriving, imaginative science centre established by Dr Michael Gore (see AIP, May 1981) and featured in a recent ABC Science Show. Opportunities for visiting the Questacon are offered in the Congress program.

I look forward to seeing you at the Congress.

The Australian Physicist, Vol. 19, July 1982 — Page 120
Sunday 22 August 1982.
5.00 - 9.00
Registration at Burton and Garran Halls.

Monday 23 August 1982.
9.00 - 11.00
Registration at the Australian Academy of Science.
11.00
Opening Session, Australian Academy of Science.
Opening of the Congress, Professor Sir Mark Oliphant.
Supporting remarks, Professor B. Ramachandra Rao, Andhra University, India.
Opening address and welcome to the ANU, Professor Peter Karmel, Vice Chancellor.

Tertiary Education Funding — Implications for Scientific Training and Research.

Professor Peter Karmel took up his present appointment as Vice-Chancellor of the Australian National University on July 6, 1982. Previously he had been Professor of Economics at the University of Adelaide, 1950-62, Principal-Designate and subsequently Vice-Chancellor of Flinders University of South Australia, 1962-71, Chairman of the Universities Commission, 1971-77 and Chairman of the Commonwealth Tertiary Education Commission, 1977-82. He is a Fellow of the Academy of Social Sciences in Australia and of the Australian College of Education. He was Chairman of the Australia Council, 1974-76, Chairman of the Interim Council and subsequently Chancellor of the University of Papua-New Guinea, 1965-70, and has been President of the Australian Council for Education Research since 1979.

12.15
Lunch

1.30 - 5.45
Convenors: Dr. D.H. Chaplin and Dr P. Lynam.

1.30 - 2.15 A1
Professor J.H. Fremlin
University of Birmingham, UK.

Applications of Nuclear Physics to Medicine.

John Fremlin is a professor emeritus of the Department of Physics of the University of Birmingham. He gained his Ph.D at Cambridge University in 1938 and, after a period on the research staff of Standard Telephones and Cables Limited, joined the University of Birmingham in 1945 as a Nuffield Research Fellow, working on the construction and assembly of the 60" cyclotron. He continued his career at Birmingham, being awarded his D.Sc. there in 1957 and being appointed Professor of Applied Radioactivity in 1963. His interests have always been wide-ranging. Recent and current topics of research include in vivo neutron activation analysis, the measurement of radon in dwelling houses and the measurement of plutonium transfer from shellfish through the gut of rats.

2.15 - 3.00 A2
Professor L.W. Davies and Dr D.R. Nicol, AWA Research Laboratory.

Physics Applied to Electronics and Communications.

Louis W. Davies, AO, FTS, FAA, graduated with B.Sc. from Sydney University and gained his D.Phil. at the Clarendon Laboratory, Oxford University, England. From 1951 to 1960 he was Research Officer and Senior Research Officer, Division of Radio Physics, CSIRO, at Chippendale, N.S.W. Dr Davies joined AWA in 1960 and was responsible for establishing AWA's Physical Laboratories. In 1972 he became Chief Scientist of Amalgamated Wireless (Australia) Limited in charge of the AWA Research Laboratory, North Ryde. He is also Visiting Professor in the Electrical Engineering School at the University of New South Wales, a position he had held since 1965.

Don Nicol graduated with a B.Sc(Honours) in Physics from Aberdeen University, Scotland, in 1960. He then joined the United Kingdom Atomic Energy Authority as a Scientific Officer stationed at AWRE. In 1963 Dr Nicol emigrated to Canada and joined the research laboratories of RCA Victor Company Ltd. in Montreal. In 1966 Dr Nicol came to Australia as a teaching fellow in physics at Monash University receiving his Ph.D in 1971. Dr Nicol joined the AWA Research Laboratory in 1970. He has been associated with research and development on optical fibres since their inception in AWA in 1972.

3.00 - 3.30
Refreshments.

3.30 - 4.15
Dr W.A. Steyert, Los Alamos, USA.

Magnetic Refrigeration.

Dr. Steyert received his B.S. in physics from the Massachusetts Institute of Technology and his M.S. and Ph.D. in physics from the California Institute of Technology. As a Research Associate working for John C. Wheatley at the University of Illinois, he studied the

The Australian Physicist, Vol. 19, July 1982 — Page 121
thermodynamic properties of $^3$He between 0.007 and 0.1 K. Steyert came to Los Alamos, where he did solid state physics work using the Mossbauer Effect as a tool. In 1966 he built the first $^3$He-$^4$He dilution refrigerator in the U.S., which was used to provide temperatures in the millikelvin region to study dilute alloy magnetism (Kondo Effect). It was later used to observe a 1/4% parity violating gamma ray emission, to study certain nuclear physics problems, and to provide ultrasensitive tests of time reversal invariance through studies of nuclei aligned at temperatures down to 1/2 mK.

More recently Dr. Steyert has examined magnetic refrigeration methods in the 2 K and 300 K regions. He has prepared ultra-compact cryogenic heat exchangers; he has developed oxygen treatments for copper to increase its thermal and electrical conductivity below 20 K by an order of magnitude; he has added small amounts of Gd,O$_2$ to copper to increase its specific heat near 4 K by orders of magnitude. For this last invention, promising for increasing the stability of superconducting magnets, he received the first Distinguished Patent Award conferred by the Los Alamos National Laboratory (May, 1981).

4.15 - 5.00 A4
Professor R.E. Collins, University of Sydney
Is Applied Physics Academically Respectable?
After graduating from the University of Sydney in 1961, Dick Collins spent four years at Amalgamated Wireless Australasia Ltd, as a Research Physicist. In 1965 he commenced Ph.D. studies at New York University concurrently working as an instructor in the Physics Department. His thesis research was concerned with electron-atom scattering processes. Returning to AWA in 1968 he held positions of Senior Research Physicist and Chief Physicist. His principal research interests were electron optics, semiconductor devices, acoustics and electrets. He also interacted closely with several of the production areas in AWA and with outside organizations. Highly applied work of this type continues to be one of his major interests. In 1978 he became Principal Lecturer and Head, Physics Department at the New South Wales Institute of Technology and in 1980 took up the chair of Applied Physics at the University of Sydney. In this position he is responsible for the solar energy research programme at the University and has been actively working towards the transfer into industry of the technology that has been generated by the University.

5.00 - 5.45 A5
Professor F.J.M. Farley, Royal Military College of Science, Shrigley, UK
Power from the Ocean Wave.
Dr F.J.M. Farley, FRS, is a graduate of Cambridge University who has made contributions to war-time radar, reactor physics, cosmic rays and particle physics. He has worked in Canada, New Zealand and Switzerland, and is currently Dean of the Royal Military College of Science, Shrigley, UK. He has been interested in wave power since 1977 and has proposed two novel wave-power machines. In 1980 he was awarded the Hughes Medal from the Royal Society in relation to work carried out at CERN over an eleven year period, 1957-67, and, later, as a Visiting Scientist to CERN. These series of experiments included the well known 'g-2' determination of the anomalous magnetic moment of the muon and, as well, various experimental tests of relativity.

7.30 - 9.00
Congress Reception, University House, ANU.

Tuesday, 24 August 1982.

9.00 - 12.15
Session B: Alternative Energy Sources I (Joint Session with RACI)
Convener: Dr G.B. Gilmour and Dr N.B. Manson.

9.00 - 9.45 B1
Dr R.H.B. Excell, Asian Institute of Technology, Bangkok, Thailand.
Alternative Energy Sources in South East Asia.
Dr Robert H.B. Excell, Associate Professor of Applied Physics in the Asian Institute of Technology, was born in England in 1933 and was educated at King's College School, Wimbledon, and Magdalen College, Oxford. He obtained his D. Phil. in 1962 for research in low temperature physics at the Clarendon Laboratory.

He then came to Thailand where he taught mathematics and theoretical physics in Chulalongkorn University before joining AIT in 1972. In recent years he has devoted much of his time to solar energy research. He is a member of the International Solar Energy Society and a regular contributor to its journal SOLAR ENERGY.

In AIT he is on the Faculty of the Division of Energy Technology, and is Associate Director of the Renewable Energy Resources Information Centre.

9.45 - 10.30 B2
Dr W.H.F. Sasse, CSIRO, Division of Applied Organic Chemistry.
Approaches to the Photochemical Conversion and Storage of Solar Energy — An Overview.

Dr W.H.F. Sasse is a graduate of the University of Adelaide where, apart from a postdoctoral fellowship at Harvard University, he also taught organic chemistry until he joined CSIRO in 1964. At present he is a chief research scientist in the Division of Applied Organic Chemistry. His research interests include organic synthesis, biologically active compounds and photochemistry. He is a member of the organizing committee for the Fourth International Conference on the Photochemical Conversion and Storage of Solar Energy (Israel 1982).

10.30 - 10.50
Refreshments.
10.50 - 11.30 B3
Professor D. Haneman, University of New South Wales.
Recent Developments in Thin Film Photovoltaics.
Professor D. Haneman has worked for many years in the field of semiconductor surfaces and in recent years also on photovoltaic conversion of solar energy in thin film semiconductor interfaces, particularly cadmium selenide photoelectrochemical cells and also amorphous silicon. He has been Senior Lecturer and Associate Professor at the School of Physics, University of New South Wales, with extended periods as visiting professor at Brown University (Providence, U.S.A.), the Hebrew University (Jerusalem), University of California at Berkeley and Xerox Research Center (California). Degrees include D.Sc. from University of Sydney, Ph.D. from University of Reading (U.K.) and B.Sc. Honours (Class I) from University of Sydney. He has been NSF Senior Foreign Scientist Fellow (U.S.A.), N.A.S.A. Lunar Sample Principal Investigator at the University of New South Wales, and is currently a member of various International Conference Advisory Committees, Australian representative to the Surface Science Division of the International Union. Chairman of the 1984 International Conference on Solid Films and Surfaces, and on various Australian Institute of Physics and Royal Australian Chemical Institute Committees.

11.30 - 12.15 B4
Professor J.O.M. Brockris and Dr M.A.K. Lodhi, Texas A & M University, USA.
The Extraction of Energy on a Large Scale from Gravitational Sources.
Professor J.O.M. Brockris obtained his B.Sc., Ph.D., and D.Sc. from London University and is now Professor of Chemistry at the Texas A & M University. Previously he was Professor of Electrochemistry at the University of Pennsylvania, 1962-72, and Professor of Physical Chemistry, Flanders University, 1972-77. He has received many honours and awards including the Breyer Medal of the Royal Australian Chemical Society in 1972 and the Faraday Medal of the Royal Chemical Society in 1979.

12.15
Lunch.
1.30 - 2.30
Session D: Contributed Posters.
Convenor: Dr S.J. Campbell.
2.30 - 5.45
Session D: Space Physics and Astronomy.
Convenor: Professor W.A. Runciman.
2.30 - 3.00 D1
Dr J.P. Kerwin, National Aeronautics and Space Administration, Canberra.
Application of the Shuttle Environment for Space Physics Experiments.
Dr Joseph P. Kerwin is Senior Scientific Representative in Australia for the U.S. National Aeronautics and Space Administration (NASA). He has worked with NASA since 1965, when he was selected as a Scientist-Astronaut. He is detailed to NASA from the U.S. Navy and holds the rank of Captain, Medical Corps. Prior to his current assignment, Dr Kerwin was a member of a three-man crew assigned to the thermal vacuum testing of prototype CM (Apollo Training Vehicle 21V-1) in 1968;

Science Pilot Skylab 2, first manned orbiting space station mission, May 25 to June 22, 1973; participated in NASA's "Outlook for Space" study; and has held the positions of Chief of Scientist-Astronauts; Chief of the Life Sciences; Head of Mission Specialist Group and On-Orbit Branch, Astronaut Office, Space Shuttle Program, JSC.
Dr Kerwin is a Fellow of the Aerospace Medical Association and the American Astronautical Society, and a member of the Aircraft Owners and Pilots Association, and Phi Beta Pi. Dr Kerwin was awarded the NASA Distinguished Service Medal, the Johnson Space Center Commendation Medal (1970); the Navy Distinguished Service Medal and Astronaut Wings (1973); the Stritch Medal from Loyola University's Stritch School of Medicine (1973); and the Aerospace Medical Association's Hubertus Strughold Award (1974); and many other awards.

3.00 - 3.25
Refreshments.
3.25 - 4.00 D2
Dr P.L. Dyson, La Trobe University.
An Active Space Shuttle Experiment: Waves in Space Plasmas (WISP).
Dr Peter Dyson obtained his B.Sc. and Ph.D. degrees at Melbourne University. He was appointed Queen Elizabeth II Research Fellow at La Trobe University in 1969 and is currently a Reader in Physics at La Trobe University. He has been a Resident Research Associate at Goddard Space Flight Centre, 1967-69, and Senior Resident Research Associate, 1977-78, and a Visiting Scientist at the University of Texas at Dallas, 1972-73. He is a co-investigator of the Waves in Space Plasmas (WISP) project currently being developed by NASA and the National Research Council of Canada to fly on the space shuttle.

4.00 - 4.50 D3
Dr C.H. Stemberg, Jet Propulsion Laboratory, USA.
Voyager Science Results.
Dr Charles Stemberg received the Ph.D degree in 1964 from Texas Institute of Technology where he majored in Physical Chemistry. He has been employed at the Jet Propulsion Laboratory since 1958 where he was Group Leader for the Viking Gas Chromatograph Mass Spectrometer science breadboard development and later was Staff Scientist in the Flight Projects Planning Office. Currently he is Manager of the Voyager Flight Service Office.

4.50 - 5.10 D4
Dr A.W. Rodgers, ANU
Starlab — The Scientific Aims.
Dr A.W. Rodgers is a Professorial Fellow, Mount Stromlo and Siding Spring Observatories, A.N.U. His research interests are galactic evolution, stellar composition, pulsating stars and stellar chromospheres, low level light detectors and high speed spectrographs.

The Australian Physicist, Vol. 19, July 1982 — Page 123
5.10 - 5.30 D5
Mr T.E. Stapinski, ANU.
A Wide Field, High Resolution Detector for the Starlab Instrument Package.

Ted Stapinski graduated from Queensland University with honours in Electronic Engineering in 1968. After working in private industry he joined Mount Stromlo Observatory in 1971 as a Project Engineer and in 1974 became Chief Electronic Engineer. He completed a part-time Master of Engineering Science degree at the University of New South Wales in 1973. He was appointed as Project Manager of the Australian STARLAB project after the STARLAB Industrial Symposium at the end of 1981.

7.30
Session E: Public Lecture, Australian Academy of Science
E1
Dr J.S. Bell, CERN, Switzerland.
Quantum Theory and Physical Reality.

Dr John Bell obtained his B.Sc. at Queen's University of Belfast and his Ph.D. at the University of Birmingham. He was at AERE, Harwell from 1950-60 and is currently at CERN, Geneva. He has worked on the theory of electromagnetic fields, of nuclei, of quantum fields, of elementary particles and on the fundamental problems of quantum theory. He was elected to Fellowship of the Royal Society in 1972.

Wednesday, 25 August 1982.
9.00 - 12.15
Session F: Alternative Energy Sources II.
Convenors: Dr G.B. Gillman and Dr N.B. Manson.

9.00 - 9.45 F1
Dr M.S. A. Sastroamidjojo
Universitas Gadjah Mada, Indonesia.
An Overview of Alternative Energy Research in Indonesia with Special Emphasis on "Green Energy".

Dr M.S. A. Sastroamidjojo obtained a B.Sc. degree from MIT, Boston, USA, a M.Sc.E from UCLA, Los Angeles, USA, and completed his formal education with a Ph.D in Solid State Physics from the Australian National University in 1974. After returning to Indonesia he has been involved in teaching experimental physics and now heads the Solid State and Energy Laboratories. He has also been involved in research in biology, medicine and food technology. His other interests include teaching science in a society mainly interested in the past and investigations of how Javanese shadow play influences Indonesian thinking!

9.45 - 10.30 F2
Dr H. Saddler, ANU.
The Incorporation of New Energy Technology into Existing Energy System.

Dr Hugh Saddler is a part time Visiting Fellow at the Centre for Resource and Environmental Studies, ANU, and co-director of a two man consultancy firm specializing in energy, economics and policy. He was trained as a natural scientist, but since 1969 has worked as a management consultant and policy analyst in London and Australia. He has written widely on energy, technology and environmental policy.

10.30 - 10.50
Refreshments.
10.50 - 11.30 F3
Dr S. Radhakrishna, Indian Institute of Technology, Madras, India.
Utilisation of Alternative Energy Sources in India.

Dr S. Radhakrishna is a member of the academic staff of the Physics Department of the Indian Institute of Technology in Madras. He is secretary of the Committee on Science and Technology for the Development (COSTED) and is the executive secretary for the Asian Physical Society. He has been actively involved for several years in the teaching of physics in village communities in India.

11.30 - 12.15 F4
Dr W.J. McG Tagart
Department of Science and Technology.
Alternative Energy Sources in the Australian Context.

Dr W.J. McG Tagart was recently appointed Secretary, Department of Science and Technology following full-time membership of the Executive of C.S.I.R.O. from 1979-81. Early in his career he held a series of metallurgical posts at Sheffield and Northwester Universities, and Cranfield, before returning to Australia in 1968 to join B.H.P. where he held the positions of Manager of B.H.P. Research Laboratories and Executive Assistant to the Chief General Manager of B.H.P. He is a Fellow of the Australian Academy of Technological Sciences, the Institution of Metallurgists, the Australian Institute of Energy and the Australian Institute of Mining and Metallurgy. He was awarded the Silver Medal of the Australian Institute of Metals in 1980 and the Annual Medal of the Australian Institute of Energy in 1981.

12.15
Lunch.
1.30 - 2.30
Session G: Contributed Posters.
Convenor: Dr S.J. Campbell.

9.00 - 5.45
Cosmic Ray Workshop.
Convenor: Dr L.S. Peak
2.30 - 5.45
Alternative Energy Sources Workshop.
Convenors: Dr G.B. Gillman, Dr N.B. Manson and Dr W.J. McG Tagart.
Thursday, 26 August 1982.

9.00 - 12.15
Session I: Physics Education and Training.
Convenors: Dr A.M. Baxter and Dr R.W. Crompton.
9.00 - 9.35
Professor P. Mason Macquarie University


Peter Mason graduated from London University during the War and joined the Ministry of Supply to carry out research on piezoelectric oscillators for radar and communication equipment. As soon as the war ended, he left to pursue more peaceful avenues of research, working on optics, building and roadmaking materials, rubber and plastics, and becoming fascinated by the borderline between living and non-living things. His growing interest in biological molecules brought him to C.S.I.R.O. in Australia to study the proteins of wool, and in 1966 he was invited to take up the foundation chair of physics at Macquarie University. He has recently published "The Light Fantastic", a Penguin paperback on the science and social implications of light. His current research includes the fracture behaviour of polymers at liquid nitrogen temperatures, modelling the action of a cardiac pacemaker, and (somewhat optimistically) trying to discover how the cells of the brain control the temperature of the human body.

9.35 - 10.10

Does a Training in Physics Suit Graduates for a Career in Industry?

Dr Ward's work has always been involved with research, largely in the field of metallurgy. After leaving Cambridge in 1954 he followed on an academic career at Sheffield University, Carnegie Institute of Technology, Pittsburgh (now Carnegie-Mellon University), and McMaster University, Hamilton, Ontario where he held the Stelco Chair until his departure in 1966. He then joined BHP as Director of Research, and has until the present been responsible in varying degrees for BHP's research activities. His particular research interest is the high temperature physical chemistry of steelmaking reactions.

10.10 - 10.45
Ms J.T. Powe, James Ruse Agricultural High School, Carlingford, NSW.


Jan Powe, B.Sc, DipEd, has spent the past twenty years teaching science in its various forms, in both government and non-government schools. Since 1977 she has been Head of Science at James Ruse Agricultural High School, Carlingford, N.S.W., one of the few selective high schools in Australia, where eleven senior classes study Physics. The only senior science she has not taught is Geology, her university major! Extr-
professional involvements include: Council member and sub-editor, Science Teachers' Association of N.S.W.; writing of Curriculum Aids Documents; Regional Science Advisor; Teacher in-service implementation; N.S.W. Director of B.H.P. Science Research competition; Visiting Teacher Research Fellow, ANU, 1978-79.

10.45 - 11.05
Refreshments.

11.05 - 11.40 14
Professor B. Ramachandra Rao, Andhra University, India.

The Training of Physicists in Instrument Maintenance, Research and Development.

Professor B. Ramachandra Rao, D.Sc., F.N.A., now member of the Indian Parliament and formerly Vice-chairman of the University Grants Commission, has been working as a Professor in the Andhra University for over three decades. He has established the School of Ionospheric Studies which has made notable contributions. He is currently president of the National Academy of Sciences and also of the Indian Science Congress Association. For his outstanding contributions he was awarded the "Sir Shanti Swarup Bhatnagar Award" instituted by the Council of Scientific and Industrial Research. As University Grants Commission Vice-chairman, he has made many valuable and innovative contributions in the field of physics education. He has carried out extensive research work in the field of Ultrasonics and Space Physics.

11.40 - 12.15 15
Professor Chatar Singh, Universiti Sains Malaysia.

The Training of Physicists of Developing Countries.

Professor Chatar Singh is the President of the Asian Physical Society and is the Professor of Physics at Universiti Sains Malaysia. At the Congress he will speak on "The Training of Physicists of Developing Countries."

1.30 - 2.30
Session J: Contributed Posters.

Convenor: Dr S.J. Campbell.

2.30 - 5.45
Physics and Reality Workshop.

Convenors: Dr K. Kumar and Dr J.S. Bell.

2.30 - 5.45
Physics Education and Training Workshop.

Convenor: Dr J.P. Rayner.

2.30 - 5.45
Workshop on Numerical Procedures in Introductory Physics.

Convenor: Dr A.M. Baxter.

Cavendish and Rutherford Laboratories in Japan, Switzerland, Argentina and Australia. He became Associate Professor of Physics at Santa Barbara in 1961, the same year of publication of his well known text "Fundamentals of Modern Physics." He became Professor of Physics at Santa Barbara in 1963. He has published several books subsequently including "Quantum Physics" with Robert Resnick, and "Applied Mathematical Physics" with Wendell Hyde. He has served as editorial advisor to John Wiley and Sons, Inc., and is consulting editor for McGraw Hill Book Company, a position he has held since 1976. His research interests are centred on nuclear scattering and reactions and the passage of particles through matter.

7.00 for 7.30
Congress Dinner: ANU Staff Centre.

Guest speaker: Mr Barry O. Jones, MHR.

Physics, Politics and Other Fine Arts.

Mr Barry Jones, Shadow Minister for Science and Technology in the Australian Parliament, has been a Labor Member of the House of Representatives since 1977. Formerly a public servant, he worked as a school teacher, university lecturer, and lawyer, he has worked extensively on radio and television. As a Member of the Victorian Parliament 1972-1977 he served as Shadow Minister for Social Welfare, Aboriginal Affairs, Transport and the Arts. He took a leading role in reviving the Australian film industry as a member of the Australian Film Development Corporation 1970-75, foundation Chairman of the Australian Film and Television School 1973-75 and Chairman of the Australian Film Institute 1974-1980. He was Deputy Chairman of the Australian Council for the Arts 1969-73. He has written five books and was co-author of "The Macmillan Dictionary of Biography" 1981. His most recent book is "Sleepers, Wake!: Technology and the Future of Work" and was published by Oxford University Press in 1982.

Friday, 27 August 1982.

9.00 - 12.00
Session K: Physics in Australia, Past and Future.

Convenor: Dr A.M. Baxter.

9.00 - 9.40 K1
Professor R.W. Home, University of Melbourne.

Between Class-room and Industrial Laboratory: the Emergence of Physics as a Profession in Australia.

Rod Home's early training was in physics and he took a B.Sc. (Honours) degree at the University of Melbourne in 1959. After a few years' school teaching he resumed studies at the University of Indiana where he obtained his Ph.D. degree in History and Philosophy of Science in 1967. He was then Lecturer and Senior Lecturer at the University of Melbourne and was appointed foundation Professor of History and Philosophy of Science at that University in 1975. Two of his research projects in recent years, for which he has received ARC grants, are: The mathematization of physics in the 19th century and Physics research in Australia from 1875 to 1945.

The Australian Physicist, Vol. 19, July 1982 — Page 126
PHYSICS IN THE A.C.T.

THE AUSTRALIAN NATIONAL UNIVERSITY RESEARCH SCHOOL OF PHYSICAL SCIENCES

The Research School of Physical Sciences is one of seven Research Schools in the Institute of Advanced Studies at the University and consists of ten departments — Applied Mathematics, Astronomy — Mount Stromlo and Siding Spring Observatories, Atomic and Molecular Physics (Laboratories), Engineering Physics, Mathematics, Nuclear Physics, Plasma Research (Laboratory), Solid State Physics, Systems Engineering and Theoretical Physics. School facilities available to all departments and units include a large well-equipped workshop, an electronics section and a computing section. Central University facilities, including a Computer Services Centre, are also available. The present Director is Professor J.H. Carver.

Applied Mathematics, The Department, under Professors B.W. Ninham, FAA (Chemical Physics) and A.W. Snyder (Optical Physics and Vision), is concerned with the applications of mathematics and physical theories to the quantitative understanding of biological systems and works also in chemical physics, optics and electromagnetic theory. Principal research interests are — Vision Research: Studies on photoreceptor optics, physiological optics and neural processing are complementary to and have a close overlap with experimental work in the Departments of Neurobiology and Physiology. Optical Communications: Theoretical work on optical waveguides and related optical problems in cooperation with Telecom Australia. Chemical and Membrane Biophysics; Colloid and Surface Science: Surface and solution chemistry, electrolytes, polymers, molecular and macromolecular forces in solution, membrane biology, self assembly of biological molecules. The Department also has strong interests in the areas of theory of liquids generally, liquid crystals, theology, biophysics of photosynthesis and adsorption.

Astronomy. The Mount Stromlo and Siding Spring Observatories (Director: Professor D.S. Mathewson) has its main lines of research on the evolutionary problems in globular clusters, the interstellar medium, galactic structure, the Magellanic Clouds, external galaxies and radio sources. The Observatories operate 7 optical telescopes on Mount Stromlo and on Siding Spring, with a wide variety of advanced optical and electronic instruments for spectrography, photometry, polarimetry and direct
imaging. A 92-inch advanced technology telescope is in construction. ANU astronomers have access to the 4-metre Anglo-Australian Telescope, the 64-meter radio telescopes at Parkes and Tidbinbilla and the Two Element Synthesis Telescope (a joint CSIRO/ANU project) at Parkes, and the Fleurs Synthesis Telescope (University of Sydney). The Observatories have a vigorous guest investigator program in UV and X-ray space astronomy. A PDS microcomputer and VAX 11/780 computer are available for data reduction and image processing, and there is a link to the University’s UNIVAC system. An active theoretical group works on problems of stellar atmospheres and interiors, galactic evolution and dynamics, and radio galaxies. There is currently an academic staff complement of 20. In addition there are around 85 professional, technical and other support staff. Currently the Observatories have 20 postgraduate students.

Atomic and Molecular Physics Laboratories.

Three research units form the Laboratories:-

Diffusion Research Unit. The Unit is concerned with the study of transport properties in liquids. In particular, it specialises in the accurate measurement of diffusion coefficients in molecular liquids and electrolyte solutions. These measurements are leading to significant alterations in the theoretical approach to the interpretation of the behaviour of molecules and ions in liquids.

Electron and Ion Diffusion Unit. The Unit is engaged in theoretical and experimental studies of elastic, inelastic, and reactive scattering of low energy (less than 10 eV) electrons, ions, and neutrals with atoms and molecules, and with the application of statistical mechanics to fluids.

Charged particle-neutral interactions are studied experimentally through the measurement and interpretation of the transport properties of drifting and diffusing electron and ion ‘swarms’. Neutral-neutral interactions in this energy range are best studied by using collimated beams of atoms and molecules. A molecular beam facility incorporating a tunable infrared laser to select specific vibrational states is under development for differential cross sections measurements and high resolution spectroscopy.

Theoretical work in the Unit falls into two categories: the first gives support to the operation and interpretation of the experiments (scattering and kinetic theory), the second mainly involves non-equilibrium statistical mechanics.

Ultraviolet Physics Unit. The Unit studies problems of atmospheric aeronomic and astrophysical significance relating to the interaction of vacuum ultraviolet radiation with gaseous matter. Experimental absorption measurements are made at high spectral resolution over a range of temperatures appropriate to atmospheric conditions, and theoretical modelling of atmospheric processes is performed.

Engineering Physics. The Department, under Professor S. Kanef, conducts research in the following principal areas: laser matter interactions — spectroscopy of laser-produced plasmas, study of plasmas produced by intense laser radiation, generation of high-flux density through self-focussing of laser light in plasmas, interaction of intense laser radiation with tenuous plasmas; energy research — particularly energy conversion, transport and storage with emphasis on high temperature thermal and thermo-chemical aspects relating to the utilisation of solar energy as a primary energy source and fundamental studies in applications of wind energy; man-machine studies — basic theoretical and experimental aspects of machine auditory and visual perception, natural language processing, concept formation (pattern cognition) image processing, computer assisted teaching and learning, digital signal processing.


Nuclear Physics. The Department, under Professor J.O. Newton, FAA conducts research in nuclear structure physics. The purpose of the work is to gain a greater understanding of both the static and dynamic aspects of the isolated atomic nucleus and of its interactions with other nuclei when collisions occur. Currently the principal areas of study are: direct reactions with light and heavy ions; measurements of static quadrupole moments of excited states through Coulomb excitation; nucleus with very high angular momenta; production of exotic nuclei far from the stability line. In addition, a small group carries out work on the interaction of charged particle beams with solids; investigations of channeling, radiation damage and the optical spectroscopy of highly charged ions are made. Accelerators available for these investigations are a tandem accelerator with a 14 MV terminal, at present the most powerful of its type in the world, and a 2.5 MV electrostatic generator. These are well supported with modern detecting equipment, including an Enge split-pole magnetic spectrometer equipped with a focal plane detection system, and on-line and off-line data processing systems.

Plasma Research Laboratory. (Head: Dr S.M. Hamberger) The principal research area of this Department is concerned with the properties of high temperature plasma (1-10 million K) magnetically confined in toroidal systems. The main experimental apparatus is a high-field tokamak equipped with up-to-date diagnostics and digital data handling facilities, and powered by a large homopolar generator. The current research program includes studies of heat transport across magnetic fields, the properties of non-thermal electrons, and detailed studies of magneto-hydrodynamic instability and other fluctuation phenomena.

Other activities include research into far-infrared lasers and their applications to plasma measurements, into wave propagation and non-linear wave-particle interactions in low density plasma and their application to space and astro-physics, and spectroscopic studies of radio frequency produced plasmas.

Solid State Physics. The Department, under Professor W.A. Runciman, has two major research areas. The first is the spectroscopic study of paramagnetic centres in non-metallic materials. Research has centred on studies of 3d, 4f and 5f transition metal ions in solids at low temperatures using traditional as well as modern high resolution
laser spectroscopic methods. There is an emphasis on the use of high magnetic fields, and superconducting magnets are available for high field optical, EPR and Mosbauer measurements.

The second area of interest is the structural, magnetic and superconducting properties of metallic materials both crystalline and amorphous. Investigations are undertaken by means of the Mosbauer effect, electrical resistivity, magnetic susceptibility, electron spin resonance, high accuracy specific heat measurements and neutron diffraction. Excellent materials preparation facilities are available.

Systems Engineering. The Department, with Professor B.D.O. Anderson, FAA, FTS, has been established from 1 January 1982 and will be concentrating its research activities in the areas of control systems and signal processing. Principal areas of study include adaptive control and identification, robust control design, multivariable and large scale systems. Areas of study in the signal processing area include block processing and nonlinear filtering.

Applications work in some of these areas is also planned.

Theoretical Physics. The Department, under Professor K.J. Le Couteur, FAA, is engaged in theoretical aspects of nuclear physics, elementary particles and field theory, statistical mechanics, transport processes, solid state physics, and plasmas. These fields of work have in common many analytical methods, so that collaboration between individual members is possible.

Further Opportunities for Research. In order to retain flexibility, the Institute of Advanced Studies aims to maintain a fifty/fifty ratio of tenured/non-tenured staff as a matter of policy. Consequently, with an academic staff of around 100 in the School, there is a regular turnover of two to five-year Research Fellowships and about two non-professorial tenured appointments are made each year. Postdoctoral Fellows in situ are eligible to apply at any time for appointment to any relevant advertised position.

DEPARTMENT OF PHYSICS FACULTY OF MILITARY STUDIES THE UNIVERSITY OF NEW SOUTH WALES DUNTROOD, ACT.

Physics has been a subject in Duntroon courses since the opening of the Royal Military College in 1911. In the Depression years of the 1930's Chemistry and Physics became the responsibility of one department which continued until 1962, when they again became separate departments. Since 1946 the level of Physics courses presented has increased and from 1967, following an agreement between the University of New South Wales and the Minister for the Army, degree level courses have been offered. This has been accompanied by an extension to honours courses in Physics and postgraduate work leading to higher degrees. Higher degree students include Army officers and civilian students.

The Professor of Physics is Professor G.V.H. Wilson, who is also the Dean of the Faculty of Military Studies at RMC. He leads a team of staff and students in research in the field of Magnetism in Solids. Research in this field at Duntroon is performed with experiments on nuclear orientation, radiative detection of pulsed nuclear magnetic resonance, perturbed angular correlation, conventional nuclear magnetic resonance, specific heat and thermal modulation investigation of magnetic susceptibilities. Many of these experiments require the use of cryogenic techniques and in some cases temperatures down to 4 millidegrees absolute zero. These low temperatures are achieved with adiabatic demagnetization cryostats and the department is commissioning a recently received dilution refrigerator with a 5 millidegree base.

Research into the measurement of X-ray attenuation coefficients is headed here by Dr C.C. Creagh. Dr Creagh is currently chairman of the X-ray Attenuation Project of the Commission on Crystallographic Apparatus of the International Union of Crystallography and consultant to the Commission on Crystallographic Apparatus.

Research into atomic collisions in solids is headed by Dr E. Dennis. His group examines the changes produced in structure and composition when medium energy ions impact upon the surfaces of solid targets.

The Department of Physics is currently preparing for a change to the new campus of the Australian Defence Force Academy scheduled for completion in 1985-86. The activities of the Department will then be expanded considerably to encompass interests of the Air Force and Naval officer cadets and the associated research of these services.

APPLIED PHYSICS AND ELECTRONICS AT CANBERRA COLLEGE OF ADVANCED EDUCATION.

The Applied Physics/Electronics group at C.C.A.E. is part of the School of Applied Science which is a multi-disciplinary organisation offering courses in Chemistry, Medical Technology, Geology, Natural Resources, Geography, Cartography, Nursing Science and Materials Conservation. The group was established in 1970 under the direction of Dr G.J. Aitchison who was also the original Head of the School of Applied Science. Initially the group was solely concerned with studies in Applied Physics but over the past few years it has steadily broadened its activities so that at this stage more students are enrolled in Electronics with supporting studies in Physics than in Applied Physical Science. But students may take out the Degree of Bachelor of Applied Science in either Electronics or Applied Physics; the latter degree being recognised for membership of the A.I.P. The group consists of six academics and four support staff with assistance from other groups within the School and from other schools within the College. The principal outside link is with the School of Information Sciences which offers courses in Mathematics, Computer Programming, and most importantly in Computer hardware which is closely integrated with the Electronics interests. In addition to the Physics and Electronics activities the group also offers a first year programme in Engineering which allows students to transfer directly into the second year engineering courses offered by a number of universities and other C.A.E.'s.

At present the Computer hardware group and this group are in process of developing a new and innovative four year degree course in Communication Engineering and are planning a proposed three year degree course in Computer Science. The main Electronics interests of the course
in Computer Science. The main Electronics interests of the group currently cover the fields of Communications, Control Systems and Microcomputers while new developments in optical communications VLSI technology, and data communications are being developed. Apart from their direct teaching duties, other activities of the group include: outside consultancies, short courses in microcomputers and related areas, and the development of innovative teaching resources.

PHYSICS DEPARTMENT,
AUSTRALIAN NATIONAL UNIVERSITY.

ACADEMIC STAFF:

The Physics Department at ANU has eleven academic staff, comprising eight tenured, and three non-tenured members. Professor Stan Hinds is Head of Department, succeeding Professor D.N.F. Dunbar in 1970.

RESEARCH FIELDS:

Include Nuclear Physics, Laser Physics and Atomic Spectroscopy, Archaeometry, High-temperature Gas Dynamics. In the last of these, use is made of the Department's unique, large, free-piston, shock tunnel.

TEACHING:

Undergraduate courses are offered leading to B.Sc. (Honours) degrees. Postgraduate training leading to the M.Sc. and Ph.D. degrees is also available in the research fields stated above.

THE QUESTACON:

Is a highly-successful, participatory science centre in Canberra which was founded through the initiative of Dr M.M. Gore, a Senior Lecturer in the Department who is now the Executive Director of the Questacon. The Department in general has played a significant role in its establishment.