CONTENTS
President's Column .............................................. 107
Editorial ......................................................... 107
Letters ......................................................... 108
"Will All Matter Eventually Decay?" ...................... 109
National Chairmen — Treasurers ....................... 112
Jobs for Physicists in 1983 .............................. 113
National Technology Strategy ......................... 115
Branch News ................................................. 116
People ......................................................... 119
Book Reviews ................................................. 121
Quentron Awarded National Research Fellowships 123
Roundabout .................................................... 124
President’s Column

The 21st AGM of the Institute was held in Sydney on 13 March 1984 and the various reports as given in the January/February issue were adopted. As President I reflect on the strength of the Institute. Much of this stems from the hard work of senior officers such as the Secretary, Treasurer, Registrar and the Editor and his team. Another impressive area of strength lies in the activities of the state branches.

Recently the Minister for Science and Technology released a discussion draft on a National Technology Strategy; this draft is based largely on the deliberations of the National Technology Conference. Much of the draft, including a call for a national commitment to technology and suggestions on the means of achieving this, are in line with the submission of the Institute to the National Technology Conference (see the November 1983 issue). Draft National targets leading to a rise in the total expenditure on R and D from 1.0% GDP (1981-2) to 2.0% GDP (1995-6) are suggested with the major growth being in the private business sector.

Editorial

I again owe John Barker a debt of appreciation as he acts as Editor while I am on long service leave. He will have less time available than two years ago, but with your cooperation will enjoy the experience. I hope to be back with the October issue.

I have just received a sheaf of material from Cleveland State University which seems to be a combination of high powered advertising and common sense.

The Department of Electrical Engineering of the Fern College of Engineering has just formed an Energy Research Centre under the direction of Peter P. Groumpos to pursue research in the field of renewable energy sources. The Department offers a set of postgraduate courses in photovoltaics, and other programmes leading to M.S. and Ph.D degrees. The novel feature of the literature is the stress it places on cooperation.

Starting at home (“there are open communication channels with all others doing research in the area within the College and within the University”) they move into the local community (“Opportunities exist for doing PV research in the laboratories of the NASA Lewis Research Centre and Standard Oil Company of Ohio”) and on to the world.

(“In this same spirit of cooperation, we would be happy to place your name on our mailing list, if you wish, so that we could send you literature from our Energy Research Centre as we compile it. In return, we would like to ask you to place our centre’s name on your mailing list in order to send us any of your technical material, news releases, course offerings, or any information on program development, laboratory facilities, etc.

It is our desire to encourage a sharing of information which will help develop programs that could lead us to earlier solutions to the energy problems of our modern world. We look forward to working with you to accomplish these goals.”).

We all talk about aims like this, but seldom get beyond a network of personal friends. This letter was a reminder to me of the universality of science, and the stimulation of cooperation.

Our own Aborigines are an example of the effects of isolation. Many thousands of years of lack of communication with overseas developments left them in the stone age, even though well adapted to local conditions. I don’t want to get into sociological and anthropological arguments, but there is a lesson for us here.

Jim Graham

The Australian Physicist, Vol. 21, June 1984 — Page 107
Dear Sir,

Concerning the paper by Campbell and Campbell which appeared in *The Australian Physicist* for April. The data in the table is not accurate in that the figures for the number of staff at ANU are incorrect — since they come from the Commonwealth Universities Yearbook, I suspect we will not be the only University with incorrect data! It is a pity the paper, in draft form, was not sent to the relevant departments before publication.

We have never had 11 staff as defined in the paper. As the figures below show, we used to have 10 staff which has now dropped to 7. I suspect the figure of 11 arises from the "honorary" inclusion in the list of our then Deputy Vice-Chancellor, who was always a full-time D.V.C.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>10</td>
</tr>
<tr>
<td>1976</td>
<td>10</td>
</tr>
<tr>
<td>1977</td>
<td>9</td>
</tr>
<tr>
<td>1978</td>
<td>10</td>
</tr>
<tr>
<td>1979</td>
<td>10</td>
</tr>
<tr>
<td>1980</td>
<td>9</td>
</tr>
<tr>
<td>1981</td>
<td>9</td>
</tr>
<tr>
<td>1982</td>
<td>7</td>
</tr>
</tbody>
</table>

(average: about 9)

The figures, incidentally, show how teaching staff cuts have affected us. The numbers of students and courses offered have been substantially constant over the above years. Hence, since all lecturing staff in the department now have high teaching loads, it is clear that research output is going to drop.

S. Hinds
Professor of Physics, A.N.U.

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**Historical Optical Equipment in Australia; Two Appeals.**

I am making two appeals, first for information about microscope test rulings of H.J. Grayson and J. Shephard, and secondly for information about the optical instruments made in Australia during the 1939-45 war. The backgrounds to these appeals are as follows.

The micro-ruling engine made for microscope test plates by Mr. J. Shephard in Melbourne belongs to the Museum of Victoria and an offer has been made to restore it to working order in the workshops of the Physics Department of Monash University. This continues the work of the late John McNeill who arranged for both the diffraction ruling engine and the micro-ruling engine of H.J. Grayson to be restored in the workshops of the C.S.I.R.O. Division of Chemical Physics, Melbourne. Grayson's restored diffraction ruling engine is now in the Division of Chemical Physics and the micro-ruling engine is in the Museum of Medical History at Melbourne University.

Grayson and Shephard made their micro-ruling engines in the 1890's. The rulings from both engines were on cover slips and mounted on microscope slides. Grayson's rulings were recognised internationally to have high quality and were mentioned in the literature. References are Houstoun, R.A., A Treatise on Light, 1938, Seventh Edition, p.93 and Martin, L.C., Applied Optics, 1932, volume 2 p.97. Martin comments that a typical Grayson's ruling may have bands with separation between the lines down to 0.42 micron on the same slide. It is probable that these test rulings were not the equals of those of Nobert (1806-1881) who was able to produce test rulings with a line separation of 0.1 micron, an impossibly small distance to see in an optical microscope but a magnificent piece of optical technology. Nobert also produced diffraction gratings, which were used by Angstrom (Preston, T., The Theory of Light, 1912, Fourth Edition p.254). The story of Nobert and his rulings is well told by G.T.E. Turner (Bulletin of the Institute of Physics, London 1967, 18, 338-348).

Shephard was a rival to Grayson in Melbourne and using his own engine he produced his rulings that he sold commercially. There is a fine collection of Grayson's gratings in the C.S.I.R.O. Division of Chemical Physics. The story of the Grayson grating engine and his grating was well known and was given in full by John McNeill in Records of the Australian Academy of Science 2, 1972, 18-38. In the collection of Grayson's gratings there are a few Grayson rulings and one Shephard ruling on which the closest separation of the ruled lines is 0.5 micron. This has professionally printed slips of paper announcing what it carries and was clearly designed to be sold over Shephard's name, in a letter to the Victorian Naturalist 12, 1895-6, p.8 Shephard makes it clear that he made the rulings to be sold. In the collection there is no Grayson ruling that can be compared with the Shephard ruling and it would be very desirable to have more rulings of both men to make comparisons.

This is the background to my appeal for information about Grayson and Shephard microscope test rulings which played their part in the development of microscopy and optical technology in Australia. There is every likelihood that there will be some still in Australia, especially in Melbourne; they could accompany older microscopes.

While I am making this appeal I would like to add a comment on the optical instruments made in Australia during the 1939-45 war. A full list is given in J.S. Roger's History of the Scientific Instruments and Optical Panel, initially Optical Munitions Panel, c.1947, unpublished, Appendix III. I was asked by Mr. F. Tough of Tough Instruments Scientific Company, Perth, W.A. if I knew of any collection of these instruments. The Tough firm, then trading under F. Tough, Perth made some of these instruments during the war. It is quite likely that some of these instruments are in museums round Australia but many may still be in laboratories or even in private hands. I am not able to accept these instruments myself since there are no museum facilities at Monash and I think that the right place for them is in the nearest museum but I am prepared to receive information about them and if it seems worthwhile I will write a later note on this information.

I am sending this note to the *Australian Physicist*, to the new Journal, *Australian Lasers and Optics* and to several museums and Laboratories in Australia.

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"WILL ALL MATTER EVENTUALLY DECAY?"
Part I: Conservation Laws

A 1983 Winter Series Lecture
R. Delbourgo, Physics Department, University of Tasmania.

The title is phrased as a question. Normally I detest interrogative titles. Like you, I suspect, I remain dissatisfied until I receive a precise answer to a well posed question, especially a scientific question which is amenable to accurate investigation. Why then did I hedge my bets in the title? The reason is quite simply the current experimental ambivalence towards providing the exact answer. At present this issue of "matter decay" is a burning one and remains the cause of some controversy between rival experimental factions; I anticipate that the arguments will be resolved by the end of 1984 and that the first unambiguous result will capture the news headlines. The quest is very exciting and promises a Nobel Prize to the individuals with the first clearcut value of the proton lifetime that is accepted all round.

That nothing is immutable must seem utterly obvious. We are all born, live our allotted span and die. Humans will eventually decay! Some, unfortunately, decay more rapidly than others, keeping the medical profession in business. Do you recall this snatch from the Mikado?

"To the matter that you mention I have given some attention and I think I am sufficiently decayed."

— W.S. Gilbert

It may surprise some of you to know that when we are past our prime we may lose as many as 30,000 brain neurons every day; this decline accelerates with age until we are overtaken by one of the natural causes of death or by senility (when the process ceases to be of direct concern). However, although our chemicals undergo radical change, we have not, until very recently, ever considered the matter within us to have really decayed, rather we have conceived it as being recycled. All of us today are breathing some of the air that Julius Caesar inhaled and which formed part of his organic self 2000 years ago. Let me give you three quotations attesting to this view.

"Die and be transformed" — GOETHE

"Our life passes in transformation" — RILKE

"Earth to earth, ashes to dust, dust to dust" — PRAYER BOOK

Not only are living creatures ephemeral, a lot of the inorganic matter also undergoes change. The empty beer can by the wayside will eventually oxidise, the mountain behind Hobart will eventually erode and be replaced by other geological features, the sun itself will eventually expand and shrink into a white dwarf. Marcus Aurelius was perfectly right in affirming that:

"The whole universe is transformation."

You may find it illuminating to compare the ages or lifetimes of various decaying systems in the following Table:

<table>
<thead>
<tr>
<th>Material</th>
<th>Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{19}$F Mesons (Pions)</td>
<td>$10^{-16}$ seconds</td>
</tr>
<tr>
<td>Mu Mesons (Muons)</td>
<td>$10^{-4}$ seconds</td>
</tr>
<tr>
<td>Free Neutrons (n)</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Radon Gas (Rn)</td>
<td>4 days</td>
</tr>
<tr>
<td>Human Beings</td>
<td>70 years</td>
</tr>
<tr>
<td>Radium (Ra)</td>
<td>1600 years</td>
</tr>
<tr>
<td>Uranium (U)</td>
<td>10$^9$ years</td>
</tr>
<tr>
<td>Universe</td>
<td>$&gt;10^9$ years</td>
</tr>
</tbody>
</table>

Given the temporary nature of nearly everything, we should seek to follow Whitehead's precept that

"The aims of scientific thought are to see the general in the particular and the eternal in the transitory."

Science, and physics in particular, seeks these eternal truths in laws that are deemed to have existed since the creation of the universe, throughout its evolution and until the end of time. Within their structure, these laws contain certain dynamical quantities which are believed to be rigorously conserved at every stage of the universe's development.

The theme of this lecture concerns one of the most significant dynamical quantities, termed the ATOMIC MASS NUMBER and commonly abbreviated by the letter A. As usually formulated, A measures the amount of matter in a system. More exactly, A equals the total number of protons and neutrons in a system, with each proton or neutron carrying one unit of A. Thus A is a whole number. (Incidentally, the antiproton and antineutron carry $A = -1$.) The universe has been estimated to have an A-number of 10$^9$, to one or two orders of magnitude! Until a few years ago, A was thought to be absolutely unvarying in each and every section of the universe, but this belief has been seriously eroded with the coming of "unified force theories", so much so that experiments have been under way since 1980 to provide us with decisive answers about the age of matter.

In order to lead up to this quest and its significance for modern theories, I should first indicate why certain quantities are expected to have a permanent character. You have all heard the phrases,

"The Law of CONSERVATION OF ENERGY" or "The Law of CONSERVATION OF MOMENTUM" (in 3 directions actually).

These particular laws are deeply rooted in the fact that the way we write these laws is independent of where and when we do so; Einstein's principle of general relativity. Without such a "covariance" principle, science would become meaningless: a textbook written by a Martian could be very different in content, let alone vocabulary, from the Earthman's version! It is quite inconceivable to me that the covariance principle is false. Surprisingly, one can prove that this liberty of changing description (or coordinate system) independently anywhere anytime, besides not affecting the laws, demands the existence of a gravitational field and a Newtonian force law of gravity. Following from such a simple tenet, these conclusions are truly amazing!

Though the total energy embodied in the laws has to be conserved, it can be transmuted from one form into another; this degradation of energy WILL take place if the system increases in disorder from one configuration to the next, unless some rule prevents it. This is exactly what happens when something decays: in that event, it disintegrates into a collection of systems of lower total mass because the final state is more disordered and energy has been released.

This brings me to a beautiful example of energy conservation and degradation which plays a key role in the stability of matter. It is also one of the most enthralling detective stories of this century. Let us go back to about 1900 when Becquerel discovered the
phenomenon of radioactivity. The importance of the discovery cannot be overemphasized, for it shattered one of the most cherished laws of the time, namely the imperishability of chemical species. Until that time it was a cornerstone of chemistry that the atoms composing the elements in a compound were distinct and unalterable. In chemical reactions like
\[
\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{HOH}
\]
o no atomic transfigurations were tolerated or contemplated! On the contrary, Dalton had taught us that each atom maintained its identity and had to balance faithfully on each side of the chemical equation. Imagine the shock to this ideal when radioactive transitions of the type
\[
^4\text{C} \rightarrow ^{14}\text{N} + \text{e}^+ + \nu
\]
or
\[
^6\text{K} \rightarrow ^{16}\text{Ca} + \text{e}^+ + \nu
\]
began to be isolated. The chemical laws were literally breaking down before one’s eyes! Later on came the realization that only the inners of the atoms, or “nuclei”, were subject to the radioactive process; one could understand the above decays as being due to a single elementary transition of a neutron into a proton with the release of a visible electron.
\[
\text{n} \rightarrow \text{p}^+ + \text{e}^- + \nu
\]
This “beta-decay” Process is shown in figure 1 and is the basic reason why chemical species are not always immutable.

![Diagram showing beta-decay process](image)

Figure 1: An example of Beta Decay. “K → ^{16}\text{Ca} + \text{e}^+ + \nu”

There was one measure of consolation about the new order of things. This was that the A-number did not alter anyway in these beta-decays. The same applied to radioactive “alpha-decays” of the type
\[
\text{Ra} \rightarrow \text{Rn} + \text{He}
\]
\[
A = 226 \rightarrow 222 + 4
\]

So well did this rule seem to hold in the new chemistry that it was elevated in status to a new “Law of CONSERVATION OF ATOMIC MASS NUMBER.” But perhaps the most fascinating part of this story concerns the question mark lurking on the right-hand side of the beta-processes above.

Careful experimental measurements of the initial and final masses and of the heat released showed that something was badly amiss with energy conservation. Also the linear and angular momentum did not appear to balance properly on either side of the equation. Thus physicists were forced into one of two possible conclusions: either the laws of energy-momentum conservation were wrong, or something was given off in beta-decay that escaped detection and carried off the excess energy-momentum. Pauli and Fermi bravely subscribed to the second option and postulated the existence of an uncharged, invisible particle called the neutrino, which was responsible for restoring energy-momentum balance. The neutrino had to interact very weakly indeed with matter to explain its exceptional elusiveness. In fact millions upon millions are passing right through you every day and you do not notice them. Because of their weak interaction they are very hard to detect. It took many years before they were unequivocally spotted. Reines and Cowan found them through the inverse beta-process,
\[
\bar{\nu}_e + \text{p}^+ \rightarrow \text{n} + \text{e}^-
\]
using an atomic reactor as a plentiful source of initial neutrinos. Remember that A-number is conserved in beta-decay because the electron and the neutrino (both light particles or “leptons”) carry A = 0. This idea of A or matter conservation is vital in “explaining” why the proton itself does not spontaneously fission into a positive electron with the emission of light (a gamma ray):
\[
A = 1 \rightarrow 0 + 0.
\]
Without an A-balancing act there would be nothing to prevent the proton, and by implication all stable nuclei, from dying.

To persuade you that A-conservation rule is itself suspect, I want to contrast it with another, more familiar rule, the “law of CONSERVATION OF CHARGE Q” which is on a much sounder theoretical footing. Charge conservation has been tested to greater and greater accuracy for over a century and no known instance of its breaking has been uncovered to date. To help you appreciate why charge is expected to balance completely in any process, let me say a few words about charged particles, their force fields and the notion of “charge symmetry”.

As you may be aware, light can be represented by waves or by particles; indeed quantum mechanics teaches us to regard light as propagating in the form of “wave packets”. Figure 2 shows a wave packet of light or a “photon” with a certain amplitude.

![Wave packet diagram](image)

Figure 2: A wavepacket of light. The amplitude of oscillation can correspond to the electric or magnetic field.

This perspective on lumps of light extends to other material particles. Electrons, too, move in wave packets; so do photons, so do neutrons, and so on. Each one of you sitting here is a packet. However the electron wave packet (a charged field) is different from the photon wave packet (or electromagnetic field) in one important respect. It possesses an extra degree of freedom connecting the fact that it carries charge. At a single instant and place, the photon amplitude is real whereas the electron amplitude is “complex” — having a magnitude and a phase. Loosely speaking we may liken the electron to alternating current from the mains supply and the photon to direct current from a battery. Thus the electron wave has a phase which varies from point to point while a photon always has zero phase. Figure 3 illustrates this.
Figure 3: Phase and amplitude of an electron wave contrasted to a photon wave.

With this picture in mind we may envisage the electron phase as being changed by a rotation in "charge space", the amount of rotation being determined by the charge carried: double the charge and you double the rotation; conversely the proton which carries positive charge will rotate equally and oppositely to the electron wave under the same charge rotation, as drawn in figure 4.

Figure 4: Relative changes of phase for electrons and protons.

Experimentally one is only able to measure real quantities so the "Principle of LOCAL CHARGE SYMMETRY" stipulates that at any place and time only the magnitudes of charged particle amplitudes are observable; the physical results cannot depend on how much we charge rotate the phases. From such a simple rule one can prove a number of far-reaching consequences:

1. Under acceleration, electrons must emit Q-waves of light. (These are photons or c.m. waves)

Figure 5a: Emission of a photon by an electron.

2. These Q-waves travel exactly with the speed of light, c. (Photons have zero mass)

Figure 5b: Propagation of a photon of same frequency.

3. Such waves carry unit spin. (Light comes with two states of polarisation)

Figure 5c: Polarisation states of photon waves.

4. Any space-time event automatically and absolutely conserves charge.

5. The force between two charged particles is "mediated" by light. The exchange of a photon influences their motion and causes them to feel the "Coulomb Law":

\[ \text{FORCE} = \frac{(Q\times \text{Charge 1}) \times (Q\times \text{Charge 2})}{(Q\times \text{Charge separation})^2} \]

\[ \begin{array}{ccc}
\text{e}^- & \text{e}^- & Q=1 \\
\text{p}^+ & \text{p}^+ & Q=1 \\
\end{array} \]

Figure 6: Interaction between two charges (in the H-atom) due to photon exchange.

If one abandons the notion of charge symmetry then most if not all of the above conclusions come to grief. Since Coulomb's Law has been tested to many orders of magnitude and all the other predictions have been verified time and again, there is not the slightest doubt about the truth of Q-number conservation. Figure 7 is a picture of a high-energy reaction

\[ \Pi^+ + P^+ \rightarrow P^+ + 2\Pi^+ + 8\Pi^+ \]

Figure 7: Multipion production (CERN).

where we can see charge conservation at work you will notice an equal number of magnetic deflections to the right and left.

There are two excellent reasons for entertaining misgivings about the counterpart "law of LOCAL A-NUMBER CONSERVATION". In the first place, protons or neutrons do NOT emit A-wave analogues of electromagnetic waves — at least they would have to be unbelievably weak to have escaped detection so far. In the second place, if the earth with its \(10^{20}\) protons and neutrons were the source of an A-field, it would attract bodies towards its surface similarly to gravity. There would be an analogue of Coulomb's law,

\[ \text{A-FORCE} = \frac{(A\times \text{Charge 1}) \times (A\times \text{Charge 2})}{(A\times \text{Charge separation})^2} \]

Figure 8: Influence of A-charge forces on a test body outside the earth.

The Australian Scientist, Vol. 21, June 1984 — Page 111
However, for bodies of the same mass but of different composition, the A-forces would be slightly different, so the overall attractive force to the earth would distinguish between them. Experimentally, to extreme accuracy, there is no evidence whatever supporting A-force modifications to gravity. These arguments compel us to disbelieve A-conservation despite the strong empirical evidence in its favour.

Actually there are good precedents for thinking that the A-number conservation might be broken at a fundamental level. The analogy I have in mind is the violation of the so-called STRANGENESS quantum number S, which is revealed in certain elementary particle reactions:

\[
\begin{align*}
\text{Strong reaction} & \quad \Pi^+ + P^- \rightarrow K^0 + A^0 \\
S &= 0 \quad 0 \quad 0 \quad -1 \quad 1 \\
A &= 0 \quad 1 \quad 0 \quad 1
\end{align*}
\]

\[
\begin{align*}
\text{Fast rate} & \quad \ K^0 \rightarrow e^- + \nu_e \\
S &= 1 \quad 0 \quad 0 \\
A &= 0 \quad 0
\end{align*}
\]

\[
\begin{align*}
\text{Weak reaction} & \quad \ K^+ \rightarrow e^+ + \nu_e \\
S &= 1 \quad 0 \quad 0 \\
A &= 0 \quad 0
\end{align*}
\]

Particle physicists have grown accustomed to and accept the idea that S-number is conserved in fast or nuclear reactions but violated in slow or weak processes. Today we look at A-breaking in the same spirit.

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**Australian Institute of Physics**

**CHAIRMEN & TREASURERS**

(for secretaries, see inside front cover)

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Jobs for Physicists in 1983 — Still Very Steady as the Economy turns the Corner

John R. Prescott, Physics Department, University of Adelaide

Your reporter has now been covering the Australian employment scene for some six years by monitoring advertisements in the daily press. The original study covered all major Australian newspapers on a sampling basis and the “Australian”, “Age”, “Sydney Morning Herald” and “Advertiser” in detail for part of 1978 and all of 1979. Subsequent surveys in 1980, 1981, 1982 (and now 1983) have included only the “Australian” since it carries the overwhelming majority of positions for which an honours or higher degree in physics, applied physics or geophysics would be suitable. A detailed discussion of the various fields of physics employment was included in the original article and will not be repeated here. The categories themselves appear in the table.

One of the interesting things about the employment market place is that, in spite of the recession and unemployment elsewhere in the workforce, the number of advertisements for physicists has remained almost constant: 660 in 1983 compared with 680 in 1982, 690 in 1981 and 680 in 1980. The proportion of positions for which a Ph.D. was a stated requirement has stayed steady at close to 20% since 1978. During 1982 there was a certain morbid fascination in watching the employment opportunities in the private sector decrease to less than half the number that they showed at the beginning of the year. In 1983 there was an equal fascination in watching them begin to grow back in. One is reminded of the growth back to secular equilibrium of a radioactive decay chain that has been depleted in the middle.

According to the ANZ Bank Employment Advertisement series, seasonally adjusted advertisements for jobs in all categories, which fell from 20,000 per week in January 1982 to a low of 10,500 per week in January 1983, and recovered to 15,000 in January 1984 and are rising strongly still. This trend is closely reflected in the positions suitable for physicists in private industry and commerce and advertised over the same period. It shows particularly in positions for geophysics which hit a low point late in 1982 but which had recovered significantly by December 1983. These trends are less obvious when viewed over a January-December survey year than when taken over a financial year because of the shape of the recession trough relative to the calendar and therefore the extreme do not appear in Table 1, which gives the percentage of positions in the various categories of employment for the past four years. Each column is headed by the total number of advertised positions recorded.

Apart from the general trend just discussed, there are relatively few differences in the detailed structure of the table as between 1982 and 1983. Perhaps the most encouraging feature is an increase in both permanent and limited term appointments in CSIRO, which is currently recruiting physicists at its highest rate since the surveys began in 1978. At the same time the various Defence research establishments have been somewhat less active in their recruiting than they were last year. They are not separately listed but account for about 30% of the “Not CSIRO” component of Commonwealth government recruiting. The net total activity of the Commonwealth government is up only slightly from 1982 to 1983 when these movements are accounted for.

It is interesting to note the slow decline in State government appointments over the past three years. Looking back over this period, it would appear likely that it reflects a fall in recruiting of physical scientists for environmental monitoring which peaked around 1979-80.

The tertiary education sector continues to be depressed with only a tiny handful of tenable appointments in either Universities or CAE’s. We can record one event unique in the past five years: A teacher-training CAE advertised for and appointed a tenable physicist. Another first is a half-time tenable lectureship. As usual, ANU accounts for the lion’s share of temporary academic appointments. Perhaps a faint sign that the academic scene may be brightening lies in an increase in limited term lectureships. While it is perhaps not of itself statistically significant and, while it is true that the posts are temporary, nevertheless there are some new lecturers getting into the system at last.

Another interesting feature is the increased number of positions suitable for theoretical or mathematical physicists. These are to be found (shyness spread is true) over the whole range of positions and not just in the academic world. Most of the non-academic positions are for mathematical modeling or for theoretical analysis in a joint programme with experimentalists. Perhaps I noticed these posts this year after a colleague challenged my optimism with the comment that things may be OK for experimentalists but not for theoreticians. The actual count of such posts was about 70.

The independent schools are still advertising widely for qualified physics teachers (82 advertisements this time) and they have been joined by Education Departments of the States and Territories. Only Queensland and Tasmania have not done so in 1983. The Northern Territory is still offering scholarship support for teachers to train. Victoria seems to be offering special incentives to attract teachers (without actually saying so) and, for the first time, South Australia is advertising posts in specific schools. Clearly the problem of a short-fall of qualified physics teachers seems destined to remain with us for the immediate future.

Geophysics is listed separately because it is usually regarded as “geo” rather than “physics” in Australia but it does provide employment for some physics graduates.

Overall the total number of posts is down slightly on last year. In fact, the difference of about 20 positions is accounted for by the fact that 1982 had been a bumper year for overseas advertisements in the Australian press (mostly for academic appointments in S.E. Asia, Niugini, Oceania and New Zealand). The number of Australian posts is almost the same.

By way of comparison it is interesting to examine overseas trends. The American Institute of Physics

The Australian Physicist, Vol. 21, June 1984 — Page 113
reports that new Ph.D.'s at December 1982 were finding it somewhat harder to find suitable employment than had been the case before and that there were more holders of Bachelor degrees out of work. However, perhaps reflecting the Australian experience, the market for theoreticians had improved.

Across the Atlantic in England, Pearson of the Institute of Manpower Studies reports dreary prospects for new graduates, for whom unemployment rates have been rising steadily since 1979 in all categories of science and technology. Pearson's report does not list physics separately but since maths, computing science and electrical engineering were least affected, one may infer that physics graduates are not as badly off as biologists, 20% of whom were still unemployed six months after graduation.

One further cautionary note may be worth adding: Over the past year or so entry to electrical engineering courses has become highly competitive. There seems no doubt that some of the brightest young people who might otherwise have taken physics are now doing engineering. These graduates will make competition for physicists in those jobs for which either qualification would serve.

Summary

Employment prospects in Australia for physicists seem sound. The government laboratories are taking on staff in a range of disciplines. Any graduates prepared to look beyond their immediate expertise should be able to find a satisfactory position. As in previous years it is doubtful if there are sufficient local Ph.D. graduates to fill all of the positions available in this country. If Barry Jones' "sunrise industries" get off the ground a critical shortage of physics graduates will result.

References

ADVERTISED POSITIONS IN "THE AUSTRALIAN"

All jobs, advertised in "The Australian", for which a degree in Physics, Applied Physics or diploma in Applied Physics provides a suitable starting point. All figures are percentages.

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The Australian Physicist, Vol. 21, June 1984 — Page 114
NATIONAL TECHNOLOGY STRATEGY
Outline of Discussion Draft
Department of Science and Technology

In his preface to the Discussion Draft, Barry Jones says "My main objective at the Conference was to achieve a 'shock of recognition' among the participants — a sharp and growing awareness of the range and speed of the technological revolution, of where Australia stood in comparison with other nations with mature economies and the extent to which we needed to reconsider the appropriateness of conventional economic wisdom. Other objectives were to promote dialogue between those concerned with technology issues — industry, unions, public service, the research sector; and to draw the attention of the media to the central role of technology in economic development."

"An undertaking was given at the Conference that a document would be circulated to participants and made available for public discussion before being submitted to Government for adoption and action. This discussion draft fulfills that undertaking."

Mr Jones said "The discussion draft is an important document for Australia. I hope it will be debated widely."

"We cannot guarantee that implementation of a National Technology Strategy will ensure Australia's economic prosperity. We can, however, guarantee a continuation of the relative decline of Australia's living standards if we do nothing."

The National Science Strategy
The Strategy has four parts, each based on a theme of the National Technology Conference.
Major elements within these parts are discussed under the headings Policy Principles, Objectives and Actions.
The Strategy represents a guide to action which is visible to all policy makers inside and outside government.
The broad goals for the Strategy are to:

1. strengthen Australia's science and technology infrastructure so that Australia is better able to manage the process of technological development;
2. help revitalise the Australian economy through the widespread adoption of new and existing technologies;
3. ensure that the benefits and costs of technology development are shared equitably among all Australians; and
4. ensure effective co-operation between all organisations with responsibilities which concern technological development.

For each of the elements outlined below, there is a list of action statements which are concrete and which could be implemented.

PART I: AUSTRALIA'S TECHNOLOGICAL CAPABILITY
Australia's technological capability consists of the totality of people, skills, procedures, equipment and organisations that use, apply, develop and diffuse technology in Australia. Australia needs the capability to develop its own technology where appropriate, to absorb and improve on the technology of others, and to apply new ideas and approaches rapidly wherever they may be useful. The Strategy identifies three elements in the development of a technological capability with these characteristics.
The first element relates to Australia's research and development (R&D) system; industrial R&D laboratories, Commonwealth and State Government research establishments, and tertiary education institutions. Specific issues associated with the level of industrial R&D are considered in Element 6.
The second element relates to the education and training system in Australia. The skills required to lead a full life in the known world are changing rapidly, and this poses particular problems for the way Australia educates its people, and trains and retains its workforce.
The third element concerns the way in which different elements of Australia's technology infrastructure interact with each other. The diffusion of technology, which often involves interaction between sectors, is also considered in this element.

PART II: TECHNOLOGY FOR ECONOMIC DEVELOPMENT
Part II examines issues involved in the vigorous exploitation of technology for Australia's economic development. In this context, industry must make the detailed decisions through which Australia's economy actually develops. The role of Government is to provide a suitable environment and the necessary incentives to encourage the application of technology in new and existing firms.
The Commonwealth Government's approach to the promotion of technology for economic development has two basic components:

— generally available assistance to support technological innovation and R&D in line with industry's perceptions of priorities (e.g. allocation of funds according to market forces); and
— selective additional assistance in key areas of technology (national priority allocation). (Elements 4 and 5).

The low level of both R&D and innovation in the private sector in Australia has been a matter of concern for many years. It has been attributed to many factors: the small domestic market, distance from international markets, reliance on overseas technology and knowledge and high levels of foreign investment in industry. Government policies, such as high levels of, and abrupt changes in, tariff protection, may also have contributed. Moreover, parts of Australian industry seem to have become more adept at lobbying Government for increased tariff protection than investing in new technology. Policy measures designed to increase industrial R&D performance need to take account of these realities of Australia's industrial structure. (Element 6).
The experience of other countries has been that a ready supply of venture capital is vital to innovation and to the formation of high technology enterprises. The Commonwealth Government has moved recently to establish a supply of venture capital through changes
to the Australian Industry Development Corporation and through the provisions of the Management and Investment Companies Act. This legislation also addresses other needs of small high technology firms, such as management expertise, and these are also discussed. (Element 7).

PART III: SOCIAL ASPECTS OF TECHNOLOGICAL CHANGE

The subtle and complex processes by which technological changes produce costs and benefits are poorly understood by most people in our society. There is a need for better understanding of these processes to help inform management and union attitudes to technological change, and to assist the development of government policies.

Given the importance of work in our society, and the primacy of the wages system as a means of distributing economic benefits, it is natural to see the major social aspect of technological change in terms of its effect on employment. As discussed in Element 8, technology can be used to improve both the long-term outlook for employment, and the nature of work in Australia.

Although there are often long-term benefits associated with technological change, there may be difficulties in the short-term. If Australia is to obtain maximum advantage from technological change, co-operation between management and unions in its introduction is essential. This issue is considered in Element 9.

Inasmuch as the concerns of society as a whole find expression in government policies and programs, many of the social aspects of technological change are reflected in areas of public sector activity. Perhaps the most important of these aspects concerns education and training, which has been dealt with in Element 2. Other issues concerning public sector technologies are discussed in Element 10.

An important determinant of the success of the National Technology Strategy will be the development of positive community attitudes towards technology: a commitment to and a confidence in technology as means of achieving social and economic goals. That commitment and that confidence will develop only if there is community understanding about technology and the effects of technological change, and if social aspects are taken into account in technological decision-making. These issues are discussed in Element 11.

PART IV: TECHNOLOGY AND INTERGOVERNMENTAL RELATIONSHIPS

Part I, II and III of this Strategy have indicated the way in which Australia intends to build up its technological capability, use that capability to apply technology for economic development, and ensure that the benefits and costs of technological change are distributed fairly throughout the community. The role of government in all these areas is crucial. Governments are in large measure responsible for the technology infrastructure, can affect the economic environment, and have substantial influence on welfare delivery and other social services.

The roles and responsibilities of the Commonwealth and State Governments need to be thoroughly understood and agreed if proper co-ordination in the implementation of the Strategy is to be achieved. Issues involved in ensuring ongoing co-ordination and co-operation are discussed in Element 12.

The actions of the governments of other countries can affect Australia's technological development. Equally, Australia can influence technological development in some other countries. The implications of these possibilities are discussed in Element 13.

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BRANCH NEWS

Gravitation in the A.C.T. Branch

Professor Bergmann of the U.S.A. proved to be a rare attraction at the opening meeting for 1984 of the A.C.T. Branch. Audience at the Oliphant Building in spite of the blustery, autumnal evening chill on 20 March. He is Research Professor of Physics at New York University and Professor of Physics at Syracuse University. On this occasion he was accompanied by his wife, herself a renowned X-ray crystallographer. Professor Bergmann's subject was "Gravitation" and it was clear from the barrage of questions at the end of the talk that the choice of topic and the eminence of the speaker had combined to attract a well above average audience from Canberra's community of physicists and physics students.

Professor Bergmann is an internationally acclaimed authority on the Theory of General Relativity in which he had been deeply involved since his days as a research assistant to Albert Einstein, prior to the U.S. involvement in World War II. He had published two books on the subject "Introduction to the Theory of Relativity" in 1946 and, "The Riddle of Gravitation" in 1969.

He opened his talk by warning the audience that the topics he would cover are normally addressed to post-graduate students at the rate of three lectures a week for a whole academic year! This was hardly surprising in view of the topic selections presented under the four headings:

- Newton's Theory versus General Relativity,
- The Schwarzschild's solution,
- Cosmology,
- Experimental tests of General Relativity.

Nevertheless, having gauged the extensive background of expertise in the particular audience, these topics were addressed in a single hour. This, Professor Bergmann proceeded to do with the quiet, unhurried calm of a true expert in a most difficult and often abstract subject. All distortions and misinterpretations in the following account remain the sole responsibility of your reporter, a simple solid state physicist whose geodesic describes events strictly in a laboratory of the non-free-falling kind.

The basic underlying postulates of Newton's Theory were first examined. Law One assumes a global inertial frame of reference. Law Two, which says that absolute vectorial force is equal to mass multiplied by vectorial acceleration, defines an intrinsic characteristic of a particle, the inertial mass, m, which is independent of the vectorial force.

Within the Newton framework the force law of gravitation,

\[ F = \frac{G \cdot m_1 \cdot m_2}{r^2} \]

is an action at a distance law, not a field theory, for in
the Newton theory 'r' is the instantaneous distance between two bodies of masses M and m. Using Newton's second law we can define the acceleration of one body of mass m under the influence of the other of mass M as,

\[ \mathbf{a} = -\frac{GMm}{r^2} \]

showing that the acceleration is independent of the mass of the particle. Mental pictures of feathers and moon rocks falling together from the astronaut's hand spring immediately to mind. To a theoretician, however, this is an obvious springboard into the famous Principle of Equivalence. For lesser people some quiet reading on the relationships between geodesics in Minkowski spacetime and their analogues in Riemann space-time would assist, but the important point is the peculiar property of gravitation leading to accelerated motion independent of mass. Contrast this with the force of acceleration in an electrostatic field on two unequal charges.

The Principle of Equivalence may be stated formally as,

The equations of motion of a particle in a gravitational field, uniform or non-uniform, are represented by the equations of the geodesics in an appropriately chosen Riemannian spacetime.

Fortunately Professor Bergmann didn't say this. Rather, he informed us that an observer viewing from afar the free-falling particle in the Earth's gravitational field in Australia and in the U.S.A. would be less inclined to describe these events identically than an observer whose frame of reference is locally matched to the free fall. Inertial frames cannot be absolutely determined because of the Principle of Equivalence. In addition there is no absolute "now" in Special and General Relativity. This leads to the introduction of the postulates of the Theory of General Relativity, referenced to the gravitational field:

1. The non-extendability of free-falling frames of reference indicates that space-time is curved, not flat.
2. The ten possible gravitational potentials are identical with the metric tensor field. (Hint: they are the coefficients of the metric, or components of the metric tensor in four space).
3. The potentials obey second order differential equations conjectured by Einstein through analogy with electromagnetic field equations.
4. The particles or bodies move on geodesics.

Explanations of the earliest formal solution to Einstein's gravitational equations, the Schwarzschild solution, were next presented and compared made with the inverse square law. The Schwarzschild radius, \[ R = \frac{2GM}{c^2} \]

found from calculating the escape velocity of a particle with velocity c from the gravitational potential of a body of mass M was introduced. The Schwarzschild radii for the Earth and the Sun are found to be 10 mm and 3 km respectively.

In 1960 Kruskal and Szekeres deviated from earlier theoretical approaches in which the gravitational field was manifestly independent of the chosen co-ordinate system. In their approach the apparent speed of light remains constant but the field changes with time. Although at first accepted as just another abstraction allowed within the broad guidelines of General Relativity, this theory is currently the basis for the physical description of black holes. The talk now eased into cosmology and in particular the consequences of space-time curvature. Professor Bergmann made the following points:

- General Relativity allows many different models of the physical universe;
- astronomical observations suggest that the Universe is expanding (the Hubble effect) and probably has expanded for 10^10 years;
- It is not known whether expansion will be followed ultimately by collapse.

An interesting aside was his reference to the Gamow prediction of remnant background radiation following the big bang, heralding the very beginning of our currently favoured model of the Universe. This microwave radiation was actually discovered by Penzias and Wilson which they interpreted as residual noise in their communications satellite antenna. Subsequently this cosmic radiation was found to possess a distribution in accord with Planck's radiation law with a temperature of 2.7 degrees Kelvin. Gamow had predicted ten times this temperature and through the Stefan Boltzmann Law was a mere 10^10 too high in predicted intensity. To your simple, solid state physicist/reporter Boltzmann at this point in the talk suddenly assumed a far greater significance than merely describing radiation heat leaks into a cryostat. With current nucleon densities, Gamow's prediction becomes 5 degrees Kelvin, in remarkable agreement!

The final section of the talk concentrated on observable effects in support of General Relativity. Since it encompasses Newton's Laws to first order, second order effects must be examined to distinguish between the two. Four such effects were discussed:

1. The gravitational red shift from the Sun's radiation, from white dwarfs and in terrestrial experiments using the Mossbauer effect;
2. Deflection of light by large masses such as the Sun as observed during eclipses;
3. Time delay experiments using interplanetary radar;
4. Perihelion advances of Mercury's orbit under the influence of the Sun's gravitational field, or better, in binary pulsars.

Professor Bergmann might be expected to staunchly support General Relativity but he presented refreshing objective criticism of some of the above measurement results as representing verification of the theory. According to him the Sun is not a good subject to demonstrate gravitational red shift because it is a distributed source having spectra grossly broadened by pressure and temperature. Since the famous experiments in light deflection during the 1919 eclipse, observations have not in general strongly supported quantitative agreement with the predictions of General Relativity. And continued study of Mercury's perihelion advance has shown it to be embarrassingly small. On the positive side, however, gravitational shifts from white dwarfs and from studies of the Mossbauer effect seem clearly in support of General Relativity while the perihelion advance of a binary pulsar is of the order of minutes of arc a year rather than a century as seems to be the case for Mercury.

During discussion after his talk Professor Bergmann presented a delightful analogue to the Schwarzschild barrier paradox that gravitational waves from the collapsed interior of a black hole cannot escape and yet the gravitational field can influence the motion of a companion bright star. He compared this to the penetration by an electrostatic field of the sharp interface between two media of differing refractive index while light from a source within a denser medium is totally internally reflected at incident angles above the critical.

The final conclusion of a thoroughly enjoyable and illuminating talk is best expressed in Professor
Bergmann’s own words:

Whenever General Relativity leads to observable deviations from earlier theories, observations have confirmed the predictions of General Relativity. This is also true in cases where newer theories have competed with General Relativity — SO FAR!

D.H. Chaplin

Student Prizes — A.C.T. Branch

The annual prizes for best second year physics students in the A.C.T. were presented on 20 March at the first branch meeting for 1984. The winners this year were James S.M. Beck of RMC, Timothy S. Bourke of ANU and W.D. Fallow of CCAE. The prizes this year were each $90 plus a year’s student membership of AIP. After the meeting, the three students were guests of the Branch at the dinner given for the guest speaker, Professor Bergmann and his wife.

Western Australia

The W.A. Branch decided to start 1984 with its first meeting at the Fremantle Sailing Club at the invitation of Rear Commodore R.F. Fleya. An excellent buffet was followed by an illustrated talk “On the Impact of Satellite Remote Sensing on the Sport of Game Fishing”. The speaker was D. Myers from W.A.I.T. The turnout was excellent.

The second meeting of the season, held at W.A.I.T., was preceded by wine and cheese and again a large audience, over 60 people, was in attendance. This was a joint meeting of the A.I.P. and the W.A. branch of the Australian Society of Exploration Geophysicists. The lecturer was Dr F.J. van Kann, U.W.A. describing progress made with the Prototype Cryogenic Superconducting Gravity Gradiometer for Geophysical Exploration. He introduced his present co-workers, C. Edwards, M.J. Buckingham with R.C. Penny as graduate student, and, judging from the intricate precise workmanship of the instrument, an excellent technical support team.

In a very clear introduction he stated reasons why measurement of the earth’s gravitational gradient tensor is superior to direct field measurement if you intended to record changes in the terrestrial gravitational field due to changes in the composition of the earth’s crust. The instrumental noise level in a state of the art graviometer enables the detection of a $10^{-14}$ tonne mass anomaly at a distance of 1km. At this distance, the fully developed gradiometer will have equivalent sensitivity. But, because of the different distance dependence of the gradient, the gradiometer is relatively more sensitive than the gravimeter to anomalies closer than 1km. Moreover, the gradiometer is less sensitive to the effects of uncertainties in the altitude of the instrument and the presence of even relatively distant topographical features. The most significant advantage of a gradiometer is that it can be used in a moving vehicle, since it can be made insensitive to translational accelerations.

He then described the present prototype instrument, whose techniques are based on knowledge gained from gravity wave detection research work, as follows:

Two masses in a cryostat are constrained by springs (Fig.1) made of Beryllium Copper Alloy. The movement between the masses of the order of $10^{-14}$m, is detected by a coil made of superconducting wire. The current changes in the superconductor are transferred to and measured by a SQUID magnetometer. The transference of the current changes requires a highly sophisticated technique which enables true measurements of current changes after eliminating many noise problems.

A test wheel of wood and lead blocks rotating at known frequency in proximity to the gradiometer recorded a peak in the observed spectrum corresponding to the wheel motion. But excessive low frequency noise was observed in the spectrum. This was found to be caused by flux creep in the Niobium-Titanium alloy wire used to make the superconducting coils. These are now being replaced by pure Niobium wire.

![Figure 1: One Gradiometer Test Mass and 2 Beryllium Copper Alloy Springs.](image1)

![Figure 2: The Prototype Cryogenic Superconducting Gravity Gradiometer and its two Slave Physicsicats, C. Edwards and F.J. van Kann.](image2)

The lecture was exceedingly interesting. The fact that a prototype cryogenic superconducting gravity gradiometer (Fig.2) has been shown to work in the laboratory environment, represents a great achievement.

G.H. Thompson
People

Visitors to the University of Queensland:

Dr D. Doornbos of the Royal Norwegian Council for Scientific and Industrial Research — Norwegian Seismic Array (NTNF/NORSAR), from July to December 1984. Activities/Interests: Seismology and physics of earth's deep interior.

Mr Xu Chang Fang of the Institute of Geology, State Seismological Bureau, Beijing, China, from February to the end of 1984. Activities/Interests: Magnetotelluric techniques.

Professor D. Haneman of the School of Physics, University of New South Wales, who is Australian representative on the Surface Science Division of the International Union of Vacuum Science, Techniques and Applications, has been elected in an international ballot as a member of the seven person Committee of the Division. IUVSTA has currently 23 member countries with several new membership applications in process. Professor Haneman is Chairman of the RACI Solid State Division.

Mr R.W. de M. Maclay sometime Science Master of Sydney Grammar School, Head of the Physics Department of Sydney Teachers College, and member of the Standing Committee of the RACI Chemical Education Division, has been awarded the external PhD of the University of London for his after-retirement research thesis 'The psychomotor domain taxonomy of educational objectives, and development of instruments to measure attainment of psychomotor skills in selected educational areas of vocational significance'. The instruments included those for experimental and practical skills in science, dentistry, and industrial arts.

Dr Jacob Israelachvili has been awarded a major Australian research prize for his work in developing a unique, ultra high-precision apparatus in which forces between two solid surfaces separated by a liquid can be measured. The radius of an atom.

Dr Israelachvili has been named this year's joint winner of the $2000 David Syme Research Prize. He shares the award with Les Bursill, Senior Lecturer in Physics, University of Melbourne.

The prize is awarded annually by Melbourne University for the best original research in biology, physics, chemistry or geology produced in Australia during the previous two years.

Dr Israelachvili is Professorial Fellow in Surface Physics in the Department of Applied Mathematics, RSP/Phys, at ANU.

His pioneering work with his colleagues on the direct measurement of the forces between solid surfaces separated by water has proved the existence not only of the classical electrostatic repulsive forces but also the newly-identified structural forces caused by the special arrangements of water molecules in the first layers adjacent to solid surfaces.

This has particular relevance to the intermembrane layers of biological cells organise ions and water structure around them, thereby regulating the interactions between them.

Other applications include the swelling of soils when saturated by rain, understanding how detergents act at the molecular level, and understanding how particles disperse in a liquid in such areas as foodstuffs, mineral extraction processes and pharmaceutical dispersions.

The following visitors will be taking part in the AIP Sixth National Congress in Brisbane in August.

Professor Alfred Bork, Professor of Physics and Information and Computer Science, University of California, is founder of the Physics Computer Development Centre at the University of California, Irvine. This project is one of the major projects in the world for development of computer-based educational material. Bork is also Adjunct Professor of Physics at the University of Utah.

The Centre has about one hundred visitors a year, coming from all parts of the world, and has received several requests for information about computer-based systems. The Centre's reputation is based on the very high quality, graphic, highly interactive, individualised, computer-based learning material it has developed.

Professor Peter Dunn, Department of Engineering, University of Reading, will give at least one keynote address in Appropriate Technology and/or Small Scale Renewable Energy Resources. He is one of the leaders in the field of appropriate technology, having written a book on the subject, and running a Master's course in Renewable Energy at the University of Reading. He is a man of very wide experience and a brilliant speaker.

Appropriate technology, small-scale technology and renewable energy resources are perceived to be of great importance in the Australian and Eurasian context. He is also able to speak on training in alternative energy and appropriate technology, and Stirling engines.

Professor John Smith of the University of Strathclyde is the Professor of Microbiology and will be speaking at Biotechnology/Microbiology meetings as well as the Congress. His possible topics at the Congress are transfer technology and technology and business studies — a novel degree program.

Professor Francis Farley of the Royal Military College of Science, Shrivenham, is a distinguished scientist, with interests in many areas of physics. He will speak at the Congress on one or more of: Ship propulsion by ocean waves, New methods of photon and particle detection and experimental tests of the theory of relativity.

He is prepared to speak on these or other topics, including wave energy conversion, theory of water waves, early experiences in radar, quantum electrodynamics, G-2 experiments on electron and muon, spin motion matrix methods in optics, and from QED to QCD via quarks, colour and charm.

1984 Pawsey Medal Awarded

The Australian Academy of Science has announced the award of the Pawsey Medal for 1984 to Professor Wood of the Mount Stromlo Observatory for his distinguished scientific research.

Professor Wood's research has been in the study of the final stages in the life history of stars of the same mass as our Sun. These stages are important both because they are then a star regurgitates material back into the interstellar gas out of which it formed at its birth. For much of its life (as long as several thousand million years) a star behaves very quietly, simply burning hydrogen into helium, and ridding itself of the enormous energy thus produced by radiating it away as light into the space between the stars. For the last 10 percent of its life, however, the processes occurring in the star's interior...
become increasingly more complex. The nuclear burning proceeds to heavier and heavier elements, and the outside layers of the star have periods when they become very distended (the giant star phases). Not only that, it is at these stages that various forms of stellar instability occur. Some such giant stars, called Mira variables, begin to pulsate regularly with periods of a year or so. Sometimes matter from the nuclear processed inner regions of the star is mixed to the surface; and finally the star begins to shed material by a variety of mechanisms. Some giant stars lose so much matter that they become visible as infrared sources, and even as radio masers.

Eventually much of the outer layer of the star is thrown off in what is called a planetary nebula shell. Thus the products of the nuclear burnings that were originally locked away in the very centre of the star can finally be dispersed into the interstellar gas. Dr Wood's work has been instrumental in clarifying just how stars can cause the heavier elements to build up in galaxies, and ultimately in the Universe at large. He has used many techniques to achieve this, ranging from the calculation of the life histories of stars using large computers, to the observation of the diameters of planetary nebulae shells 170,000 light years distant in the Magellanic Clouds using a special device called a Speckle interferometer. The heavier elements which are produced in these processes of nucleosynthesis are important in that it is out of these elements that our earth, and we ourselves, are made.

Dr Peter Wood was educated at the University of Queensland and the Australian National University. He joined Mount Stromlo and Siding Spring Observatories in 1976 and now holds the position of senior research fellow.

The Pawsey Medal was endowed to commemorate the unique contribution to science in Australia by the late Dr J.L. Pawsey FAA.

* * *

The following people took part in the AIP Seminar on Nuclear Arms at ANZAS last month.

Dr George Rathjens graduated from Yale University in 1946 with a B.S. in chemistry and received a Ph.D. from the University of California (Berkeley) in 1951. He taught chemistry at Columbia University from 1950-53 and did research on molecular structure while there and also during 1958-59 at Harvard. He is now Professor of Political Science at MIT, where he has been since 1968.

Dr Rathjens spent most of the period 1953-68 as an advisor to the National Security Council in Washington.

Specifically he served on the staff of the Weapons Systems Evaluation Group of the Department of Defence, on the staff of the President's Science Advisor, as Chief Scientist (1961) and then as Deputy Director (1961-62) of the Advanced Research Projects Agency of the Department of Defence, as Deputy Assistant Director (1961-62) of the Advanced Research Projects Agency of the Department of Defence, as Deputy Assistant Director for Science and Technology and as Special Assistant to the Director of the U.S. Arms Control and Disarmament Agency, as Director of the Systems Evaluation Division of the Institute for Defense Analyses, and as deputy (on part-time leave from MIT) to Ambassador at-Large Gerard Smith, in the Department of State. In this capacity he was deputy U.S. Representative for Non-Proliferation Matters and chairman of the Management Committee for the U.S. participation in the International Nuclear Fuel Cycle Evaluation.

At MIT Professor Rathjens has done research and writing on defense and arms control policy, and on public policy problems in the civil sector, and has taught graduate seminars on systematic policy analysis where the emphasis is on technology assessment and cost benefit analysis as applied to such problems.

Greg Fry is a Postdoctoral Fellow in the Strategic and Defence Studies Centre in the Research School of Pacific Studies at ANU. He has been Senior Tutor in the Political Science Department at ANU where he lectured in Pacific Politics from 1977 to 1982. In 1981 he was a Visiting Lecturer at the University of the South Pacific in Suva. Before joining the ANU, Mr Fry was Pacific Desk Officer in the Department of Overseas Trade. His publications focus on Pacific region security issues and on the domestic politics of the Pacific Island states. In 1983 he produced a Strategic and Defence Studies Centre Working Paper which examines the Australian proposal for a nuclear-free zone in the Southwest Pacific.

Dr John Donovan is a Senior Medical Advisor in Epidemiology in the Department of Health, Canberra. Prior to joining the Department in 1974, he was jointly lecturer in Epidemiology in the London School of Hygiene and Tropical Medicine and Medical Statistician in the office of Population Census and Surveys. Most of his published work has dealt with health effects of tobacco smoking. Apart from the work to be described, he has recently completed a major study of birth defects and Vietnam service, which found no connection between malformations in the child and Vietnam service of the father.

Mr Ian Gahally, Principal Research Scientist at CSIRO Division of Atmospheric Research, Aspendale, Victoria, has been involved in research on processes affecting atmospheric composition for the last 16 years. He has worked for extended periods in U.S.A., England and Sweden. While in Sweden in 1982 he initiated his present studies of atmospheric effects of nuclear war.

Gert Bastian, born in Munich in 1923, served in the Second World War as a young volunteer. As from December 1942, he was lieutenant in the Corps of Engineers and spent most of his active duty in Russia.

Gert became an officer in the German Armed Forces (Bundeswehr) in 1956. As a company commander, general staff officer and later as brigadier and divisional commander, Bastian fervently endeavoured to realize the guiding principle of having "citizens in uniform" and contemporary standards of moral leadership. In 1979 the general was fiercely attacked by the opposition and right-wing press because of his understanding which he had voiced with regard to the security needs of the communist states in the East.

In 1980, General Bastian expressed to the Minister of Defence his profound misgivings about NATO's decision on "modernization" and simultaneously asked to be allowed to resign. Since his retirement from active military service Bastian has been the dedicated critic of a security policy based on the build-up of the nuclear arsenal instead of working towards the -- in his view indispensable -- worldwide outlawing of nuclear weapons.

Since March 1983, Gert Bastian has been a Member of the 10th German Bundestag and representative of the GREENS parliamentary party.

Petra Karin Kelly is a member of the German Bundestag and Speaker of the Green Parliamentary Group. She was educated in Germany, U.S.A. and the Netherlands, and until election to Parliament was Administrator in European Health and Social Policy Questions at the EECE's Economic and Social Committee in Brussels.

She has been deeply involved in anti-nuclear, anti-war and feminist movements and, with a foundation to study the causes of cancer in children, has written many articles and books.

Dr Julie Dahlitz is the author of Nuclear Arms Control — with effective international agreements. She is a Research Fellow in International Law and

The Australian Physicist, Vol. 21, June 1984 — Page 120
International Relations, most recently at the International Peace Research Institute, Oslo. She has been Political Affairs Officer in the Centre for Disarmament, Department of Political and Security Council Affairs, at United Nations Headquarters in New York. Later she was appointed Consultant to the Committee on Disarmament on the prevention of an arms race in outer space. Dr Dahlitz attended both the first and second Special Sessions of the General Assembly on Disarmament, and was requested to write the ‘Account and Assessment’ of the latter Session for the United Nations. She obtained her first two degrees from Melbourne University and her Ph.D. in International Law from the Australian National University. She has recently been appointed Senior Research Fellow in the School of Peace Studies at the University of Bradford.

Among elections to the Australian Academy of Sciences, Thomas William Healy and Donald Charles Morton will be known to physicists.

Professor Healy is distinguished for contributions in the fields of surface and colloid chemistry. Professor Healy’s studies on the nature of absorbed water and his electrochemical studies on zinc and other sulphides are an important contribution to our understanding of wettability and flotation which have important applications in minerals processing. They also constitute a major contribution to the understanding of other important industrial processes involving solid suspensions. He is Professor of Physical Chemistry, University of Melbourne.

Dr Morton is distinguished for his contributions to observational and instrumental optical astronomy. He was intimately concerned with both the Princeton rocket spectrophotograph and with the highly successful Copernicus satellite. With the former he obtained the first useful stellar spectra in the rocket ultra-violet, and from his results deduced the existence of stellar winds, now recognized as a major phenomenon in the evolution and atmospheric structure of giant stars generally. From the Copernicus results he made fundamental determinations of chemical abundances in the interstellar medium. During the time he was Director (since 1970) the Anglo-Australian Telescope has consolidated its position as one of the world’s large telescopes, and has become the dominant influence in British and Australian optical astronomy.

Dr R.W. Crompton, FAA, has been appointed as the new Secretary for Physical Sciences of the Australian Academy of Science. Dr Crompton is the Head of the Atomic and Molecular Physics Laboratories at the Research School of Physical Sciences, Australian National University, and is Adjunct Professor of Physics at the University of Oklahoma. His research interests include the application of a specialized branch of gaseous electronics to atomic and molecular physics, and the research team which he leads is known internationally for its work on the scattering of low energy electrons and ions by atoms and molecules. Since his election in 1979, he has served the Academy in a number of roles. He was a former Chairman of the National Committee for Physics and is currently Chairman of the Public Lectures Committee. He is also Chairman of the Board of Standards of the Australian Journals of Scientific Research and is Chairman of the recently formed ACT Division of ANZAAS.

The A.B.C. is pleased to announce that Mr Dick Gilling has been appointed Executive Producer of Television Science Programs.

Mr Gilling will be moving from the U.K. to take up his appointment with us from June 1st, 1984.

Dick Gilling is one of the world’s leading television science producers. He has a degree in English Literature from Cambridge University and began his career as an executive producer with the B.B.C. in 1963.

Gilling’s credits include senior production roles in the programs Tomorrow’s World, Inside Information, and Medical Express. He is a founding member of the definitive Horizon documentary group and has produced, written and directed over twenty-five programs for the series ranging in subject from neurosurgery to natural history.

His series credits include producer or co-producer of: The Age of Uncertainty with J.K. Galbraith, Spaceships of the Mind with Nigel Calder, Brownowskis’ The Ascent of Man and the recently screened series The Human Brain.

The Gunn-Hilsun effect is the phenomenon of microwave generation from bulk semiconductor material due to a negative differential mobility in the velocity-field relation of certain semiconductors, notably gallium arsenide and indium phosphide. This effect has provided the operational basis of devices used for the generation, amplification and processing of microwave signals in the 1 — 100 gigahertz range.

The book is directed at those with a specialist’s interest in the design or application of these devices. It is too austere in format and narrow in scope to hold the attention of the non-specialist. Rather than being concerned with the physics of negative differential mobility, the book concentrates on the effects of contact regions to the device and of the circuit in which it is embedded upon its oscillatory behaviour. The treatment is thorough and authoritative as might be expected from the authors’ close involvement in the development of the understanding of these effects. In view of the demonstrated importance of the cathode contact region in determining device behaviour, one limitation of the treatment is the simplicity of the model of the cathode contact actually used throughout most of the book.

Reviewed by M.A. Green, School of Electric Engineering, University of NSW.

The Australian Physicist, Vol. 21, June 1984 — Page 121
Although the book contains a good discussion of the likely structure of contact regions, a simple ‘constant field’ model is used in most of its computations.

Although the Gunn-Hilsen effect has now been studied for over two decades, the book is rooted firmly in the first decade of development, despite the 1979 publication date it bears. Of the more than 350 references cited, only 11 were published after 1975. The book nonetheless provides a valuable documentation of the development of the understanding of these interesting devices.


This is a well written and clear introduction to nonlinear optics. Graduate students and researchers unfamiliar with the subject should find Levenson’s book to be a useful introductory text. In addition, it should serve as a reference for those already active in the field.

The theoretical treatment, which begins with the density matrix for a two-level system, is detailed and clear. The theory of interaction of two-level atoms with intense laser fields, developed in chapter two, is used to describe the various phenomena treated in subsequent chapters.

Topics such as saturation spectroscopy, coherent Raman spectroscopy, multiphoton absorption and optical coherent transients are treated in individual chapters. A good feature of the book is that of each chapter contains a theoretical background followed by solid experimental discussions. The description of the principles of Doppler-free spectroscopy, where Levenson has made a significant contribution, is excellent.

The description of pulsed dye lasers, in chapter one, is rather restricted and references given on this topic outdated and incomplete. The description of nonlinear sources, in chapter seven, is also limited. In particular, the description is devoid of some important theoretical and experimental details.

Apart from the minor criticisms above and some insignificant errors and misprints in equations this book is highly recommended.


During the 1960s many astrophysical phenomena were discovered, most of them previously unsuspected. For instance, X-ray stars and galaxies, quasars, the microwave background, masers, infrared sources, pulsars and the gamma-ray background. Martin Harwit examines this decade as part of the overall development of astronomy and discusses the implications. He has an original way of looking at astronomical research. He defines a major phenomenon (at least one property is new by a factor of a thousand) and estimates the number still to be identified. As a breakthrough is usually due to serendipity or technological developments for military purposes he doubts whether the present policy of funding ‘routine’ research will be an effective way of finding these phenomena. Large national observatories have not been at the forefront of discovery.

The book caters for a wide range of reader. The first chapter is a general essay presenting the ideas which are substantiated later. The second examines each of the 43 major discoveries to date. Later sections consider how the ultimate limitations to observation must restrict the number of independent discoveries and make recommendations on the emphasis of future astronomical research.


This book contains material presented at the 1976 Conference of an international group concerned with the advancement of physics teaching and demonstrates both values and problems of such a publication. The first section on the role of statistics in teaching physics is generally set at the level of Nuffield Advanced Physics and so, for Australian readers, of more interest to those teaching in the early tertiary years. Ogborne’s comparison of six approaches to teaching elementary statistical mechanics is an outstanding illustration of how the teacher must come to grips not only with the physics content but also with those educational and psychological principles which help students grasp the concepts.

The second section of the book deals with physics teaching at the junior secondary level and, among others, contains an excellent set of papers which summarise research by Delacôte’s group into student understanding of light, heat, electricity and motion. Unfortunately, these are written in French and the English abstracts are poor substitutes for the real thing.

Those with an interest in physics teaching at both the secondary and tertiary levels who read French as well as English will find much of value in this book.


The title says it all — this is a specialist’s book, and I do not expect it to appeal to many readers of this review. There are physicists who see their chosen discipline as neatly partitioned from mere mundane areas like chemistry, metallurgy, engineering etc. They will find confirmation of their beliefs in a superficial reading of this book. In fact, there is a wealth of challenging and important problems in the physics of deformation and flow in multiphase systems, and these are well treated in the introductory chapters. The later chapters deal with polymer processing operations and coextrusion.

The book is very well produced, but boasts the most inadequate subject index I have seen. Like many recent publications, it contains a list of trivial problems at the conclusion of each chapter, which presumably persuade the publishers that the book will find application as a course text. Inevitably, it is replete with jargon and solid fare for the non-specialist. I would regard this book as a valuable acquisition for any library or group interested in polymer technology or rheology.
Quentron awarded National Research Fellowships

Quentron Optics research and development division, headed by Mr John Grace, has been jointly awarded two of the recently allocated national research fellowships. Both are Industry-University co-operative ventures and are aimed at enhancing the performances and product applicability of Quentron's metal vapour lasers. The metal laser development has been supported by A.I.R. D.I.B. with project grants totalling $884,000.

The first of these new programs is entitled "Development of high mean power tunable visible lasers for industrial medical and scientific instrumentations" and is a joint project with Professor Piper of Macquarie University. The second is a "Spectroscopic investigation of fundamental output power limitations and scaling parameters in gold vapour lasers" and is being undertaken with Dr. McIntosh of the University of New England. This project is aimed directly at increasing the operating efficiency and hence output power of the gold vapour lasers used in cancer phototherapy.

Recent work at Quentron by John Grace has already uncovered a novel (Patent Pending) technique for increasing output power by 50-80%. This provides the Quentron laser with a significant market advantage and further investigation, at the University of New England, of the discharge kinetics should lead to even greater output power and further enhance this advantage.

The high mean power dye laser project undertaken with Professor Piper will extend the capabilities of the current metal lasers. Professor Piper has already made considerable progress in the development of copper laser pumped dye lasers. This development will be extended to high output powers by the research fellow and the technology transferred to Quentron for commercial development and exploitation.

Quentron and Professor Piper's group currently have a co-operative venture aimed at the commercial realisation of high mean power deep blue and uv sources. The recombination lasers under development generate output pulses of length greater than 1µS thus providing the capability of very narrow bandwidth tunable blue and green output when coupled to a dye laser. Once copper laser dye development is complete the research fellow will concentrate on the recombination dye system.

The managing director of Quentron Optics, Mr Alex Stanco, said "it was vital that fundamental scientific research be undertaken in areas which relate to the high technology products we are developing or we leave ourselves vulnerable to losing the technological lead we currently enjoy."

Mr Grace, a laser physicist trained at the University of New England, who heads the metal vapour laser program at Quentron, has approved advertisements for the Fellowships and expects two laser researchers to be appointed by July 1984.

Now that the metal vapour lasers are in the production phase it is becoming increasingly difficult to devote time to basic research at Quentron. The government's initiative in creating the Fellowships will enable the basic research program to expand without detracting from development and production during the crucial product launch phase overseas.

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QUENTRON OPTICS PTY. LIMITED
(A MEMBER OF THE QUENTRON GROUP OF COMPANIES)
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TELEPHONE (08) 233 6224
TELEX CITRON AA80869

NATIONAL RESEARCH FELLOWSHIP IN METAL VAPOUR LASERS

Applications are invited for a post-doctoral fellowship to carry out a spectroscopic investigation of fundamental output power limitations and scaling parameters of gold vapour lasers.

The position, which is supported by the National Research Fellowship's scheme is available for three years and carries a stipend of $18,000, together with other benefits.

The appointee will work largely at the University of New England, Armidale, New South Wales, but will liaise closely with the research group at Quentron.

Applicants should have a Ph.D. (or equivalent) in experimental physics and the ability to carry out diagnostic experiments on high temperature metal vapour lasers. Knowledge of spectroscopic techniques for measuring discharge parameters would be advantageous. Preference will be given to Australian citizens or residents of Australia.

Informal enquiries may be directed to either Mr. J.R. Grace (08) 233-6224 or Dr. A.I. McIntosh (067) 73-2388.

Applications should be made in writing, with the name of two referees included, and should be addressed to:-

John R. Grace,
Senior Research Physicist, Quentron,
at the above address.

The Australian Physicist, Vol. 21, June 1984 — Page 123
That Goal

An example of Space Age poetry from Frederick Koch, a member of the N.S.W. Branch.

If we never dared to set us that goal
To move into cosmic space,
We will lose the one chance mankind has got,
To save the human race.
The world as it appears to us now
Is riddling with terror and strife.
Mishandling, hunger and greed they sow
New daily threats to our life.
The lords of power themselves are caught
In the complex web of condition.
Their cautious moves with fear are fraught
Lest they blow us into perdition.
Ten thousand years of mankind's past
With ignorance, hunger, disease,
Breathe down their necks. The dice are cast!
Will science give us a new lease?
The web of conditions was woven by fate
Men of wisdom and earnest endeavor,
By brutes of olden times and of late,
Saints, sufferers and men of valour.
The pattern of mankind's fate is strange.
Evolution ticks-off day for day.
But we have got the means for gradual change,
If THEY keep their calm on our way.
The web of conditions must be altered by us.
In patient and diligent labour,
To give THEM a chance to act without fuss,
And UNIFY MANKIND with valour.
Unification asks for so high a goal!
Salvation has many meanings.
From the northern to the southern pole,
And with us peoples of so many leavings.
But we all love life, this world and the stars,
A full belly, a mate, friends and children.
Where should it all end? In terrible wars?
GOD give us HOPE, give us FAITH and SALVATION!

Frederick Koch
29.10.1983

Fibre optics

The "optical fibre revolution" has emerged from the laboratory and taken hold in Australian communications — is the country ready for it?

John Wise, fibre optics specialist with consulting engineer Crooks Michell Peacock Stewart in Sydney, believes a lack of knowledge about the new technology has held Australia back from using it.

But local manufacturers of fibre, cables and associated equipment are gearing up for increased production. Olex Cables Ltd, one of two Australian makers of the special cables, is building a new $3 million plant in Melbourne to house its expanding fibre optics division.

According to Wise, the next 10 years will see a 50-fold, perhaps 100-fold increase in the number and size of optical communications systems, with Telecom Australia leading the way.

Other government authorities and some private companies are also setting up or planning optical systems.

Telecom, which has been field-testing optical fibre cables since 1978, is currently carrying out one major trial in Brisbane and two in Melbourne. It plans to install about 50 short and medium-haul systems in the national telecommunications network by 1986.

The Brisbane installation is a 24km cable containing 5 pairs of fibres, each pair transmitting 34Mbits/s. It carries public telephone traffic between the Spring Hill and Strathpine exchanges.

One of the Melbourne systems is a 36km, 34Mbits/s cable linking the Exhibition and Dandenong exchanges. The other is a 17km, 140Mbits/s cable between the Exhibition exchange and the Maidstone microwave terminal, where it will provide a digital radio system entrance link.

Work will begin shortly on an optical communication system which Queensland Railways is installing as part of the electrification on the Kuraby-Beenleigh line. The 20km, 2Mbits/s system will provide communication on the way, using "drop and insert" repeaters.

The optical fibre cable will share ducts with power and signalling cables.

Another railway application now under way is the NSW State Rail Authority's electrification of the 47km Waterfall-Port Kembla line. This system uses a composite cable made of 50 pairs of copper wires and 3 optical fibres carrying 8Mbits/s.

The fibres will provide point-to-point communication between Waterfall and Port Kembla while the copper pairs handle short connections to stations and track-side telephones along the way.

A composite cable has also been installed by the Northern Territory Electricity Commission as part of its Darwin communications network. The 4 optical fibres in this cable will provide communications, control and data-gathering at up to 34Mbits/s, while the 50 copper pairs provide transmission line protection.

The first 23km of the 29km system was commissioned late in 1982, but the fibres have not yet been connected to terminal equipment. This will take place in late 1984, when the remaining 6km section of the cable is in place.

The line is likely to be extended 11km more in the next few years.

But most of Australia's optical communication systems are small or experimental, according to Wise.

"We probably have less than 1000 fibre-kilometres in total installed here, compared with more than 100,000km in the US," he said.

"One reason the technology is so well-established in the US is because it has been backed by the big telecommunications companies and military organisations there."

"Although Telecom has been involved in fibre optics research for more than 10 years, it is only in the past few years that the work has become oriented toward operation.

"Besides that, there are two main reasons why fibres are not used more extensively in Australia — the belief that fibre systems are very expensive and the lack of awareness of the technology's advantages and maturity."
Advantages of optical fibres over conventional twisted pairs, coaxial cables and microwave systems are:
- very wide bandwidths, which means they can carry more data and services such as video
- very low attenuation rates, which means repeaters can be spaced further apart
- immunity to electrical and electromagnetic interference, which makes them particularly useful around powerstations, transmission lines, railways and military installations
- fully dielectric protection against lightning and induced transient voltages
- special suitability for military applications and computer systems because they are difficult to tap
- small size and light weight, which facilitates handling and installation — they can often be installed in existing ducts, eliminating the need for extra trenching
- particular suitability for petrochemical plants and mining projects because they don’t spark.

Wise admits the material costs of optical-fibre systems are generally higher than for conventional methods. “But the economics depends on the individual application,” he said.

‘‘Users should not consider the hardware costs in isolation. Installation and operating costs need to be included, as well as the value of, for example, increased reliability in electrically noisy or lightning-prone areas.”

An optical fibre consists of a central, light-transmitting core surrounded by a cladding whose refractive index is 1.5% lower than the core’s. Core diameter is usually about 0.05mm and outer diameter of the cladding about 0.125mm.

For optical-fibre transmission information is converted from electrical to optical signals — pulses of light from a laser or light-emitting diode. The light travels along the fibre by a series of internal reflections at the core/cladding interface. At the receiving end, a photodiode converts the pulses back to electrical signals.

There are 3 basic types of fibres — step index, graded index and single mode. The rays of light which make up a pulse behave differently in each type of fibre, giving different performance characteristics.

In a step-index fibre the core/cladding interface is sharply defined. Although all the rays travel at the same speed, they reflect at the interface at different angles. This means they traverse a given length of fibre at different speeds and thus disperse the pulse significantly by the time it reaches the receiving end.

Because of this dispersion, step-index fibres have bandwidths of only 20-50MHz/km and can carry on only up to 50Mbit/s. They are used for low data rates over distances up to 1km.

The bandwidth limitation is largely overcome by graded-index fibres, in which the refractive index is a maximum at the core centre, decreasing parabolically to the cladding.

This grading makes the light rays follow a sinusoidal path along the fibre and, ideally, take the same time to travel a given length. As a result, these fibres have bandwidths of more than 600MHz/km and carrying capacities of 140Mbit/s over distances of 10km or more without a repeater.

Dispersion can be eliminated completely by using single-mode fibres, which are step-index fibres whose core diameters have been reduced to 5-10 microns. This allows only one ray to propagate in the fibre.

Single-mode fibres have bandwidths greater than 20GHz/km and carrying capacities of 565Mbit/s over up to 50km, but coupling, splicing and installing them is more complicated than for the other types.

These are the fibres which are used for long-distance trunk routes.

The only Australian manufacturer of optical fibres is Amalgamated Wireless (Australasia) Ltd. In the research laboratory at its North Ryde, Sydney plant AWA produces up to 200km of fibre a month.

Production begins with a German-made, pure silica glass tube 20mm in diameter and up to 500mm long. The tube, which will become the fibre cladding, is held between the chucks of a glass-working lathe while a travelling torch heats the surface to about 1700°.

Meanwhile, silicon tetrachloride and germanium tetrachloride vapors are passed into the tube. The heat makes them oxidise to silicon dioxide and germanium oxide, which are deposited on the inside of the tube.

This deposited layer will become the fibre core. Its refractive index is determined by the composition of the vapor coming in. A computer controls vapor composition and also the numbers of passes made by the torch.

After about 6 hours, when the deposited layer is about 0.4mm thick, the heat is raised to 2100°. This softens the tube until it collapses into a 14mm-diameter rod — the preform for an optical fibre.

This preform is stretched into fibre on a drawing machine. The machine has a carbon resistance furnace at the top which heats the preform to 2200° so pince rollers can stretch it into a thread 0.125mm thick.

As it is drawn, the fibre is measured by a laser gauge and given 2 coats of protective silicone resin.

Diameter of the coated fibre is 0.4mm.

The AWA machine can draw fibres up to 6km long at about 40m/minute.

Before the fibres can be made into cables, a nylon jacket must be extruded around each one. At present, Olex Cables jackets all AWA fibres.

AWA is experimenting with a process to eliminate the jacketing stage by coating the fibres with uv acrylate instead of silicone resin in the drawing machine.

Two Australian companies make cables with the jacketed fibres — Olex and Austral Standard Cables, both in Melbourne. ASC, which buys most of its fibres from Japan, is the major supplier of optical-fibre cable to Telecom. Prelli Ericsson in Sydney may also begin making the cables in the near future.

Olex, as well as making cable, at its new $3 million plant, will produce accessories such as joint enclosures and splicing materials.

Rebecca Peters
Engineers Australia

Research on evolution of stars

The research into stars in their ‘old age’ carried out by Pawsey medallist, Peter Wood is considered important because these highly evolved stars are prominent in the production of the elements.

When stars grow they increase their luminosity. For instance, when the sun is in its old age, about five thousand million years from now, it will brighten to about 5000 times its present luminosity and will swell up to such a size that it will envelop the earth in its outer layers.

Because of this behaviour in the latter stages of life these stars are called ‘red giants’.

Dr Wood and his colleagues, by combining theoretical and observational results, have been able to estimate masses and luminosities for these objects which are about to enter the stellar graveyard.

The Australian Physicist, Vol. 21, June 1984 — Page 125
It has been found that if they are more than five times as massive as our sun they explode as supernovae and eject large amounts of material such as iron, from which future stars and planets can be made.

According to Dr Wood, the less massive red giants do not suffer as dramatically a death. They gently blow away their outer layers of nuclear fuel, leaving a remnant called a 'white dwarf.'

Another interesting feature of the red giants is that their fusion reactions do not continue steadily, as in the sun. Studying these reactions requires enormous amounts of computer time.

It has been calculated that about every hundred thousand years the helium-burning reactions in a red giant suddenly flare up for about a year and liberate energy at more than ten thousand million times the rate that energy is being liberated by the sun.

This energy is deposited near the centre of star. As a consequence of this the star 'boils' furiously for a few hundred years and brings to the surface various elements that have been produced in its centre by fusion reactions.

In particular, the elements helium, carbon and nitrogen are dredged up along with heavier elements such as barium. Once these elements have been brought to the surface of the star they can be ejected back into the interstellar medium by supernova explosions or stellar winds to continue the gradual enrichment of our galaxy in these elements.

Dr Wood says that it is quite likely that the nitrogen we all breathe on earth was produced by these processes.

The most important advance in the knowledge of the red giants has been brought about by studies of these objects in the Magellanic Clouds, which are readily accessible from Mt Stromlo. It is only because of the advent of highly efficient infra-red and optical detectors over the past five or so years that it has been possible to make these studies.

Lasers could aid accurate weather forecasting

Weather-forecasting is a subject that is taken very seriously in Britain and, in a bid to improve results, scientists at a northern England university are to start using data collected by satellite-based lasers.

The University of Hull’s Department of Applied Physics has been awarded a grant of almost $92,000 for work on atmospheric measurements using coherent laser radars. The research has applications for meteorology, in examining humidity and wind velocity and in the control of pollution.

Doctors Barry Rye and Eric Thomas are developing a technique for monitoring atmospheric gases which involves the absorption of infra-red laser beams passed through them. Dust particles act as the “targets” of the radar system, while wind velocity can be determined from the speed of the dust.

The researchers hope that, in the future, it will be possible to develop mobile systems for use on the ground and possibly from aircraft and satellites. As the latter can be used to scan all the earth’s surface, the measurements obtained would be far more comprehensive than those available from existing land-based sources, and could lead to a considerable improvement in weather forecasting.

See the Australian Physicsist 16 : 164 for an Australian LIDAR — Ed.

Robot vision research

The Department of Computer Science, in the Faculties, ANU, now has the most advanced facilities in Australia for research on robotic vision.

Upgrading of the existing laboratory has meant a significant advance for Australian research in this field.

Dr Ray Jarvis has been carrying out work on robotic vision since 1978 with the support of Australian Research Grant Scheme funding. This has been complemented this year by an ANU Large Equipment Grant.

The recently-acquired equipment includes a VAX 11/750 computer, an RCI ‘real time’ image processor, two solid state colour TV cameras and a Unimate 250 robotic manipulator arm. Additionally, a laser time of flight range scanner was developed in the laboratory.

The VAX 11/750 is to be shared with Professor Richard Brent, who is working in the Very Large Scale area of microchip design.

Dr Jarvis said that essentially his work involved developing algorithms and programming the computer to determine, using mainly visual sensory input, the placement, identity and juxtaposition of objects and to direct robotic manipulation tasks upon them.

He said the new computer had the speed and memory capacity for complex and effective analysis within a timespan acceptable for ‘real time’ application.

The eventual aim of the research is to come up with a robotic ‘hand-eye’ co-ordination system able to operate in a three-dimensional environment and which could have industrial and domestic uses.

A black hole weighed

A black hole some 100 million times heavier than our sun is at the centre of the quasar-like core of galaxy NGC 4151, according to the latest results from the International Ultraviolet Explorer satellite. This is the very first time that astronomers have ‘weighed’ the centre of a quasar, and the discovery strengthens the theory that the concentrated power of quasars is due to gas swirling around a very massive black hole in the centre of a galaxy.

NGC 4151 is a spiral galaxy lying about 50 million light years away from the earth, with a central 'mini-quasar' core: a very small, bright region where gas clouds move very quickly. Such galaxies are known as Seyfert galaxies (after the astronomer who first studied them) and NGC 4151 is the nearest bright example.

Its core was investigated by an international research team whose leading members are from the Royal Greenwich Observatory; they used the 4.5 cm telescope on board the International uv Explorer satellite. Most of the ultra-violet radiation from the core region arises in an extremely compact power-house, but spectral lines at particular wavelengths come from gas clouds outside the core. Three different types of gas cloud were detected, showing up in two different spectral lines of carbon and one of magnesium. From measurements of the widths of these spectral lines, which undergo Doppler broadening, the speeds of the gas clouds were determined; the clouds closest to the centre are moving at speeds up to 14,000 km s⁻¹ (or about 30 million mph!), the intermediate clouds at 11,000 km s⁻¹ and the outer ones at the comparatively slow speed of 4000 km s⁻¹.

The clouds are lit up by the core’s radiation, and the team noticed a delay between the core flaring up and the clouds becoming brighter — a delay most likely to be due to the time it takes the radiation to travel from the core to the cloud and thus revealing the cloud’s distance from the core. The delay times show that the
fastest moving clouds are about 13 light days from the centre, the intermediate clouds about 30 light days and the farthest ones about 1 light year out.

As in the solar system, speeds decrease with distance from the centre, implying that there is a single massive body at the centre of NGC 4151 whose gravity controls the motion of the gas clouds. For each type of cloud, applying Newton’s law of gravity to the speed and distance from the centre gives very similar answers for the mass of the core — about 100 million solar masses. This mass must be inside the inner band of clouds — which has a radius of about 1/30 light year — and the only object that can be so massive, and yet so small, is a black hole.

The black hole theory is supported in another independent way. As the gas spirals into the black hole, it should form a swirling ‘accretion’ disc at a temperature of 30,000 K. The inner edge of the disc (nearest to the black hole) is the energetic powerhouse producing most of the core’s radiation, but the hot gas in the rest of the disc should produce characteristic ultraviolet radiation — new observations do indeed reveal the correct intensity of radiation over the predicted wavelength range.

This discovery is regarded as extremely significant, in that it is the first time that astronomers have determined the mass of a black hole responsible for quasar activity.

Physics Bulletin

Science Foundation Awards for Excellence

Cheques ranging in value from five to seven hundred dollars were presented to twelve Physics undergraduates by the Chancellor, Sir Hermann Black, at an informal ceremony in the School of Physics on Thursday 5 April.

Five students were presented with cheques for $500 for excellence in Physics I, four students with cheques for $600 for performance in Physics II and three students with cheques for $700 for performance in Physics III.

The awards were first given in 1982. Two of the third-year students, Ann Roberts and Lewis Ball, have now become the first to have received awards in three successive years. One of the second year students, Leon Poladian, received an award in 1983.

The Science Foundation for Physics Awards for Excellence are made on the recommendation of the Head of the School of Physics, Professor Harry Messel, on the basis of the student’s academic achievement in the year’s work in Physics.

The Chairman of the Science Foundation for Physics, Mr Ray Kirby, said the Foundation was 30 years old this year. Originally, he said, the Foundation had been set up to support research in the School, but he was very proud to be associated with the relatively recent initiative to institute awards for excellence.

Mr Kirby said the Foundation’s finances were in a very healthy state, and preparations were now underway for another International School, to be held from 26 August to 6 September next year.

Australian Nuclear Association

The Australian Nuclear Association (ANA) was formed towards the end of 1983, as an independent association of individuals having common interests in nuclear power, nuclear medicine, radiological applications, radiological protection, uranium production and other related subjects. Its object is to fulfill the long-standing need in this country for a general nuclear society similar in scope to those that have existed for many years in other technologically advanced countries.

In addition to providing a means of furthering professional interests, the ANA hopes to promote the knowledge and practice of the peaceful, safe and effective uses of nuclear science and technology.

For information: J. A. Frewsall, Secretary, ANA, PO Box 445, Sutherland, NSW 2232.

Earth stations to be equipped from Sydney

A $500,000 plant to manufacture earthstation equipment for Australia’s communication satellites has been opened by Mitsubishi Electric Australia Pty Ltd at North Ryde, Sydney.

It is the first factory producing earthstation facilities the Japanese-based company has built outside its own country.

Under contract to Aussat Pty Ltd the factory will supply, install and commission the 8 major city earthstations to be established in each state capital of Australia.

Mitsubishi general manager, Geoff Sills, said the plant has been designed to provide a new capability rather than duplicate facilities that already exist in Australia.

Initially the work will concentrate on design, assembly, quality control, testing and installation.

Orders worth about $2 million each have already been placed with various subcontractors for aerial fabrication and erection; television and sound monitor equipment; mechanical parts manufacture; racks; printed circuit cards and printed circuit card assemblies.

The company intends placing further orders worth more than $4 million with Australian firms shortly.

The plant was recently opened by the Federal Minister for Defence Support Brian Howe who said the complex will introduce new technology into Australian industry. He hopes local companies will as much as possible use the opportunities they have under the Government’s offsets program to supply equipment and components to government projects such as the satellite system.

Solar bicycle to enter mall-to-mall race

A unique machine designed at the University of Queensland is a likely starter in the proposed mall-to-mall race from Cairns to Brisbane next September.

It is a 4-seater tandem bicycle, with the pedal power provided by four riders supplemented by a rack of solar cells carried on a canopy above their heads.

The solar tandem is the brainchild of Dr Ugar Ortabasi, director of the University’s Solar Energy Research Centre, with contributions by experts from the Departments of Mechanical Engineering and Electrical Engineering.

The frame of the bike is being built in Melbourne of special lightweight tubing. The complete bike including an aerodynamically shaped photovoltaic array will cost $12,000 and is expected to be ready for delivery in April.
after which it will be extensively tested on the road and in the University's wind tunnel to check its performance.

Dr Ortabasi said 370 photovoltaic cells would, in peak conditions, develop about 355 watts of electrical energy (shaft power) which would be delivered to the rear wheel by means of an electric motor.

It is expected that the machine will be capable of a top speed around 60-70 km/h and a cruising speed of around 25 km/h on a flat surface.

Dr Ortabasi believes the unique vehicle will generate considerable interest when it takes part in the Cairns to Brisbane race and focus attention on the work being done at the Solar Energy Research Centre to harness the sun's energy.

Dr Ortabasi said it would be the first multi-passenger vehicle driven by a combination of solar and human power. The most interesting feature, he points out, is the basic principle of a human/photovoltaic hybrid system utilizing pedal power instead of conventional batteries. It is anticipated that 70 percent of the energy needed for the trip will be provided by the solar cells.

Dr Ortabasi said that it was well established that a bicycle rider represents the most energy-efficient form of locomotion on land, far ahead of the horse, dog, and other animals and incomparably superior to other mechanical means at around 25 km/h.

The team to operate the hybrid bicycle has not yet been selected. Dr Ortabasi says he is looking for 10 physically fit scientists with a dash of adventure in their make-up.

The logistics involved in organising the double tandem participation in the mall-to-mall epic are formidable. It will be accompanied by a van carrying backup facilities, including a full range of spares and food.

To cross the Brisbane River near the end of the race it is likely that the tandem will be ferried over on a beech canoe built by anthropology students to a traditional Ampleforth Islands design.

The solar bicycle project is being partly funded with a $20,000 donation from the Queensland Credit Union League as the major sponsor.

Although operated by CSIRO, the vessel is a national facility and will enable waters from tropical to sub-tropical zones to be researched.

It will be based in Hobart, alongside the new CSIRO Marine Laboratories being built at Caversham Esplanade. The buildings are expected to be fully occupied in September of this year. The buildings will house over 200 staff.

Record Wind Speed

Soviet scientists at the Russkaya Antarctic station have recorded what are claimed to be world record wind speeds. A wind gust was recently measured at 213 kilometres per hour, the highest level ever recorded anywhere. Conventional meteorological equipment will not accurately record such wind speeds and the Soviet scientists were reported as having used devices usually used to measure the air speed of aircraft. During recent high winds steel framed huts at Russkaya were buckled.

Space Telescope Renamed

The Space Telescope, America's future orbiting optical astronomical observatory scheduled for launch aboard the Space Shuttle in 1986 has been renamed the Edwin P. Hubble Space Telescope in honour of one of the nation's foremost astronomers.

Hubble's astronomical research over three decades profoundly changed our understanding of the basic structure of the universe.

Before Hubble, scientists held differing views on the extent and dimensions of the universe. It was believed that our solar system was part of a larger system which contained all the stars visible to the naked eye.

Astronomers were uncertain whether the faint spiral nebulae were also part of our Milky Way system or themselves each comprised of countless stars.

Working at the 100-inch telescope at Mount Wilson, California, Hubble succeeded in observing individual stars in the Andromeda nebula. By the end of 1924, he thus was able to show that Andromeda was many times more distant than any star within the Milky Way system. By means of similar observations of other nebulae, Hubble established that these nebulae were in fact galaxies far beyond our system.

Equally important was a later discovery by Hubble and his assistant, Milton Humason, that the universe was expanding, providing the basic evidence of the Big Bang theory. Their observations showed that external galaxies were travelling away from us, and, the more remote the galaxy, the faster it moves. This phenomena is known as Hubble's Law and the coefficient relating the distance and the velocity of the galaxy is called the Hubble constant.

Hubble was an active research scientist until his death in 1953.

The Hubble Space Telescope will be operated much like a ground-based observatory. The 94.5-inch (2.4-metre) telescope and five scientific instruments will be housed in the space observatory configuration in orbit while spacecraft command, control and scientific operations will be ground based. The observatory, which will not have any interference introduced by earth's atmosphere, will be able to look into space seven times farther than any ground-based observatory, and its imaging will have 10-20 times better resolution. Thus the Hubble Space Telescope offers the potential of making new cosmological discoveries, in the spirit of its namesake.
NASA headquarters in Washington, D.C., is responsible for the overall direction of the program; Marshall Space Flight Centre in Huntsville, Ala., has responsibility for overall project management including development of the Optical Telescope Assembly and Support Systems Module; Goddard Space Flight Centre in Greenbelt, Md., has responsibility for spacecraft operations and scientific instrumentation development; and the Space Telescope Science Institute in Baltimore, Md., has responsibility for managing the scientific investigations and the dissemination of scientific results.

IRAS Discovers its Fifth Comet

The Infrared Astronomical Satellite (IRAS) has discovered its fifth comet, and enabled its future position to be predicted without the aid of optical telescopes. IRAS is an international satellite developed and operated by NASA, the Netherlands Agency for Aerospace (NIVR) and the United Kingdom's Science and Engineering Research Council (SERC).

On July 28 the IRAS comet searching team, at the Preliminary Analysis Facility, Chilton, found what they believed was a faint comet, at very southerly declination. Unfortunately there are few telescopes suitable for confirmation of IRAS candidates in the Southern Hemisphere and bad weather prevented the object being observed.

Five weeks later, on Sept. 2, a similar object was detected and Dr. John Davies realized that it was possibly a second scan of the July 28 object. A quick calculation of the object's motion supported the belief that the two detections could be a new comet, so the positions were communicated to the Smithsonian Astrophysical Observatory (SAO), Cambridge, Mass.

The observatory confirmed that all the detections fitted a parabolic orbit, typical of long period comets. An ephemeris was calculated from the IRAS data predicting the positions of the object several weeks ahead and sent to other smaller telescopes. These telescopes are not suitable for confirmation of faint IRAS objects unless predicted positions are available, reducing the area which must be searched.

On Sept. 11, using the predicted position, Alan Gilmore and Pamela Kilmartin at Mt. John Observatory, New Zealand, identified the faint new comet and it was designated Comet IRAS 1983O. This is the first time a comet has been discovered, and its orbit successfully predicted using data from an astronomical satellite. The new comet will pass closest to the sun in November, but even then it will be outside the orbit of Mars, so it will not be visible to the naked eye.

1983O is the third comet fainter than 17th magnitude discovered by IRAS. The experience gained during the search at the Preliminary Analysis Facility will allow other faint comets to be identified during final data processing at NASA's Jet Propulsion Laboratory, Pasadena, Calif., which in turn will enable better estimates of the total number of comets to be made. A detailed understanding of the comet population is important to theories of the formation of the solar system, and the evolution of the planets.

First award of new physics prizes

A number of postgraduate and undergraduate awards in theoretical physics, financed from the Gordon and Mabel Godfrey Bequest, were given for the first time at the recent University of N.S.W. School of Physics annual presentation of prizes.

Twenty-one awards were presented at the function, held at UNSW on Wednesday 28 March in the Squarehouse.

The late Gordon Godfrey was the first lecturer in theoretical physics at UNSW, joining the staff in 1949, when the University was sited at Ultimo and known as the NSW University of Technology. He retired as an Associated Professor in 1958 and maintained strong links with UNSW and his profession until his death in 1979.

To assist the funding for teaching and research in theoretical physics at UNSW, Gordon Godfrey and his wife, Mable, donated $300,000 to the University. Up to $40,000 is available each year for awards and scholarships and to support visits by distinguished overseas physicists to the School.

All the recipients of the Gordon and Mabel Godfrey Postgraduate Award are holders of the University Medal in Theoretical Physics. Awards of $1,500 were presented to Murray Batchelor, Whayne Padden and John Bell, while Bruce Hendy received an award of $750.

The Gordon and Mabel Godfrey Award of $300 was presented to Phillip Attard.

The Gordon and Mabel Godfrey Prize in Theoretical Physics III (shared) was awarded to Maria Eberl and Stan Miklavin. One Gordon and Mabel Godfrey Prize in Theoretical Physics IV was awarded to Murray Batchelor and one to Whayne Padden.

SciTech Minister stirs Scientists

The Minister for Science and Technology, Mr Barry O. Jones, speaking at the conferring of degrees at the University of Sydney on 3 March suggested that the only stand that the scientific community of Australia had taken since the Vietnam war was on 'salaries status and professional security'.

'We ought to have a significant scientific contribution to our future's debate,' said Mr. Jones. 'So far the academics have been extraordinarily silent. The universities and the scientific community have taken a profile so low as to be indistinguishable from the horizon.'

You are our professional thinkers. Where are you when we need you?

'Just as scientists tend to avoid political involvement, the same avoidance syndrome occurs with commercial exploitation of scientific discovery,' Mr Jones said.

'Scientists have not been particularly helpful in raising community understanding about the relationship between science and society.'

They have concentrated on the work in hand, without much, if any, consideration of long-term implications.'

ASTRON aloft one year

The Soviet Union's ASTRON satellite has been in orbit for one year. Among the interesting discoveries it has made are several dwarf stars with temperatures of up to 60,000°C which are a puzzle to astronomers; and an unusual star which has a very high content of heavy elements such as lead, tungsten and uranium.
Laser promises simpler heart disease treatment

Doctors and scientists are perfecting a new laser technique that could lead to a major advance in the treatment of coronary heart disease within the next three years.

Doctors from Western Infirmary in Glasgow, Scotland, and scientists at the UK Barr and Stroud electro-optical company have been experimenting for the past year with a new 1.2 metre long fibre-optic laser. Tests have shown that the laser beam can melt away cholesterol deposits on artery walls to restore the artery to its full maximum flow.

The treatment involves insertion into the thigh, under local anaesthetic, of a flexible tube carrying a fibre optic light guide. This is fed through an artery to the affected area and then laser energy is passed along the optic to destroy the fatty deposits.

Tests have been so successful that Greater Glasgow Health Board says the laser Angioplasty treatment should be available for patients at the Western Infirmary before the end of this year.

Dr. Alex Elliot, Chief Physicist at the Western Infirmary and leader of the research team involved, stresses that the new technique is still at an early experimental stage. "We have to prove beyond a shadow of doubt that there are no side effects before we go into man," he said.

Using a specially modified laser and other advanced equipment provided by Barr and Stroud, the Western Infirmary researchers have proved that the heat from the laser beam, which is the equivalent of five watts, destroys the fatty deposits on artery walls.

The laser technique is seen as an alternative to normal bypass surgery, or as a substitute, and will probably be used on people who suffer from angina. Initial results indicate that the treatment could be carried out at intervals of three to five years if necessary.

A local anaesthetic is only required and after three days in hospital a patient could be back at work within two weeks. This compares with 10 days in hospital for open-heart surgery followed by three months convalescence.

Radiocarbon Dating Laboratory renamed

The renaming of the Radiocarbon Dating Laboratory at Sydney University to the N.W.G. Macintosh Centre for Quaternary Dating was approved by Senate at its April meeting.

The Centre is named after Neil William George Macintosh, who graduated from the University of Sydney in 1933. He returned to teach in 1944 and was Chancellor of Sydney University from 1955 until his retirement in 1973.

His wide ranging research interests in the physical anthropology and prehistory of Australian Aborigines continued until his death in 1977. He was a pioneer in research and, as a Foundation Member of the Australian Institute of Aboriginal Studies in 1961 and Chairman from 1966 to 1974, he contributed greatly to his profession.

His widow has made generous donations to the University over the past few years for the development of a Quaternary Dating Centre, using the existing Radiocarbon Dating Laboratory as a nucleus. Foremost among the research interests of the late Professor Macintosh was the dating of the Australian Fossils, both human and animal, and the dating of associated materials, such as soils, pollen and shells.

The Radiocarbon Laboratory was established twenty-seven years ago. It undertakes dating for archaeologists, prehistorians, geographers, geologists and botanists at the University of Sydney and many other institutions throughout Australia.

As well as being renamed, the N.W.G. Macintosh Centre for Quaternary Dating the unit has recently been relocated from the Department of Physical Chemistry in the Chemistry building to the ground floor, Madsen Building.

Fast reactors improve

During 1982-83 notable advances were made in improvements to the UK's fast reactor fuel cycle, with a five-fold increase being achieved in the use of fissile material, as compared with other reactor fuels. This was one of the results obtained by the United Kingdom Atomic Energy Authority and described in its Annual Report 1982-83, published recently (HMSO price £3).

The report states that Britain is among the world leaders in the development of fast reactor technology, and is in an excellent position to carry the programme forward. The fast reactor, which extracts some 80 times more energy from a given quantity of uranium as thermal reactors now in use, is therefore of major significance for the UK's and the world's future energy supplies. (The Authority's fast reactor programme is its largest single activity.)

High priority is given to improving the economic performance of advanced gas-cooled reactors (AGR's) and providing the data to meet evolving safety standards for nuclear plant. The UKAEA has given much support to the electricity generating boards, British Nuclear Fuels and the national Nuclear Corporation, towards the commissioning and operation of the five existing AGR stations and the construction of the two new ones.

A new development this year was the ability to refuel the reactors whilst they were still in operation.

A considerable research and development effort has been made on the pressurised water reactor as a viable option for the UK, with the UKAEA taking a leading role in the programme to establish the PWR's safety. Staff took part in the Sizewell planning enquiry, in support of the CEGB's case on aspects of safety and radioactive waste containment and disposal. Still in the area of safety, the UKAEA participated in the setting up of the Nuclear Industry Radioactive Waste Executive (NIREX).

Through its Culham Laboratory, the Authority has made a major contribution to JET, by providing about half the staff, technical and administration services, and assistance in the development of special heating techniques and diagnostic equipment. The laboratory's own programme has concentrated on a range of physics experiments relevant to JET and its possible successors, undertaken with its tokamak devices DITE, TOSCA and CLEO.

Contract work for the nuclear industry, both at home and abroad, brought in an income of £25.6m for the UKAEA, whilst its non-nuclear R and D work provided an income of £25.6m. More effective ways of transferring technology to industry are being developed by giving companies shared access to expensive techniques and capital facilities. Areas of interest include offshore oil technology, fibre reinforced metals and laser techniques for metal working.

Physics Bulletin
Talking to the Space Shuttle

For the first time, a group of amateur radio operators has made contact with an orbiting space vehicle. Using ham radio (2 metre band) equipment, a group of Canberra enthusiasts were able to talk to Dr. Owen K. Garriott, mission specialist. A ham radio enthusiast himself, Garriott was a science-pilot for Skylab 3 and has been a scientist-astronaut for NASA since 1965.

The contact was made as the Shuttle STS-9 made a pass from the north-west, 400 km above the Victorian Mallee district. Dr. Garriott spoke to his friend, and recent NASA representative in Australia, Dr. Joe Kerwin, himself a former astronaut. Using the specially made handheld radio, Dr. Garriott also talked to the American ambassador who welcomed STS-9 over Australia. The radio group successfully demonstrated that 2 metre radio could provide a valuable back-up to existing radio contacts with orbiting spacecraft.

Bound for a rendezvous with the comet

The tests of the Soviet interplanetary research space ships which will go for a rendezvous with the Halley Comet at the end of this year are now underway. Soviet engineers are working on this project in co-operation with experts from socialist countries as well as from France, Austria and West Germany. The project is called Vega.

The first interplanetary ship is expected to be launched on December 15 this year. A second ship will be launched soon after the first, on December 28. They will reach their destination — the beginning of 1986. While flying past Venus on their way to the comet in June 1985 the space ships will drop special modules to study the planet's surface. That will start drifting in the cloud zone of the "hot planet", carrying out a wide range of meteorological investigations. In the meantime, the ship itself will receive additional momentum after the ejection of the descent module and will "jump" into a higher trajectory bound for the meeting with the comet.

Researchers are installing various equipment on board the space ship. The television system will manage to obtain black-and-white and spectral pictures of the planet on various scales. The spatial resolution at a distance of some 10,000 km will be 180 m.

The instruments which are going to work on board the interplanetary stations include mass spectrometers, a magnetometer, an electronic analyser and a radio system to carry out "radio-scanning" of the comet's plasma, to locate the position of its nucleus, head and tail and to receive its own radiations.

Nuclear magnetic resonance scanner

Radiologists have always had at their disposal some of the most advanced techniques developed in medical physics. Scientists are continually inventing more and more accurate ways of looking inside the body without breaking the skin. First there were X-rays, and then ultrasound. Now comes a new method that promises to take radiology well into the 21st century — nuclear magnetic resonance or NMR scanning.

Although the image is very similar to a CT (Computerised Tomography) scan, this new system does not use ionising radiation. Scans can be taken at any plane through the body and the machine has the unique ability to spot changes in body function. So, rather than just seeing how cancer chemotherapy alters the size of tumours, NMR can pick up biochemical changes within the growth.

Information is obtained by using the magnetic properties of certain naturally occurring atomic nuclei in the body. No contrast medium is needed. These nuclei, when placed in a powerful magnetic field, are stimulated by radio waves of a particular frequency and release some of their absorbed energy in the form of radio signals. At present hydrogen, which occurs abundantly in body water, is used for NMR imaging.

Although the scanner's main use will be in the study of soft tissue growths and cancers, it has also shown one or two special advantages in the study of other disease processes.

Heart disease can be picked up early because NMR betrays small areas of infarct and can even reveal blockages in arteries. It can also provide information about dementia, strokes and discs at risk in the spine. One special property NMR has shown is the ability to highlight areas of demyelination in multiple sclerosis victims. Because of this a machine is now being installed at the National Hospital for Nervous Diseases in London.

NMR scanning is still in its infancy and it does have one or two drawbacks — for instance, the time needed for each scan is about four minutes. There is one problem that further development is unlikely to eliminate — the magnet used is so strong that, although no harm is done to normal patients, people with pacemakers are advised to steer well clear of the entire room the machine is housed in.

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July 9-12 Chemistry and Physics of Elastomers, Sydney. Course and Seminar.
R.P. Burford, NSW School of Chem. Eng. and Industrial Chem. P.O. Box 1, Kensington 2033.

July 9-12 9th Ann. Conference Australian Radiation Protection Society, Darwin.
Mr I.A. Prince, 1984 ARPS Conf., G.P.O. Box 1701, Darwin, NT 5794.

July 23-Aug. 17 Radioisotope Course for Graduates No. 30, Lucas Heights.
The Principal, Australian School of Nuclear Technology, Private Mail Bag, Sutherland, NSW.

Aug. 13-17 6th International Thin Film Conference (ICTF-6), Stockholm.
Dr. Soren Berg, Inst. of Technology, Uppsala University, Box 534, 751 21 Uppsala, Sweden.

Dr. J.J. Wilson, CSIRO Divn. of Chemical Physics, P.O. Box 160, Clayton, Vic. 3168.

EPLS '84 P.O. Box 24, Rundle St., Adelaide, SA 5000.

Aug. 24-30 5th International Congress on Mathematical Education, Adelaide.
ICME 5, G.P.O. Box 1729, Adelaide, S.A. 5001.

Aug. 27-31 3rd Int. Conf. on Solid Films and Surfaces, Sydney.
Prof. D. Haneman, School of Physics, UNSW, P.O. Box 1, Kensington, NSW 2033.

Dr. B.W. Thomas, Department of Physics, Q.I.T., G.P.O. Box 2434, Brisbane, 4001.

CM 2 BHN, U.K.

Sept. 13-14 The Recursion Method and its Applications. Imperial College.
Dr. D.G. Pettifor, Dept. of Mathematics, Imperial College, London, SW7, 2BZ, U.K.

Secretary, ATS, Clunies Ross House, 191 Royal Parade, Parkville, Vic, 3052.

ACMS-9 Conference, G.P.O. Box 1292, Canberra, ACT 2601.

K.R. Cook, Sec. AIP Conference, Dept of Applied Physics, RMIT, G.P.O Box 2476V, Melbourne 3001.

Dr. B.A. Cornell, CSIRO Divn. of Food Research, P.O. Box 52, North Ryde, NSW 2113.

1985

Feb. 11-14 Polymer 85 (Characterization and Analysis of Polymers). Melbourne.
Polymer 85, RACI, 191 Royal Parade, Parkville, Vic, 3052.

Feb. 17-20 Fifth National NMR Conference, Sydney.
Dr. R.S. Norton, School of Biochemistry, University of NSW, P.O. Box 1, Kensington, NSW 2033.

Dr. G. Kossor, Ultrasonics Institute, 5 Hickson Rd, Milsons Point, NSW, 2061.

Chief Executive Officer, AIMM, P.O. Box 310, Carlton South, Vic, 3053.

Conference Manager, Transport '85, IEE (Aust) 11 National Circuit, Barton, ACT 2600.

Sept 2-5 Emag '85 (with exhibition). Newcastle-upon-Tyne.
Meetings Officer, IOP, 47 Belgrave Square, London SW1X 8QX, U.K.

Sept 2-6 World Conference on Co-operative Education. Edinburgh.
Dr. L.M. Gillin, Faculty of Engineering, Swinburne Inst. of Technology, P.O. Box 218, Hawthorn 3122.

Meetings Officer, IOP, 47 Belgrave Square, London SW1X 8QX, U.K.

Sept 16-20 Gas Discharges and their Applications (8th Int. Conf.). Oxford.
Prof. H.K. Messerle, School of Electrical Engineering, University of Sydney, NSW 2006.

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Meetings Officer, IOP, 47 Belgrave Square, London SW1X 8QX, U.K.