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President’s Column
At the very end of last year the National Committee for Physics of the Australian Academy of Science produced a survey entitled “Physics in Australia, 1981” which is available from the Academy at $7.50 per copy (postage $1.50). Since I was involved in the technical phase of editing the volume, though not in its compilation, it would not be appropriate for me to attempt any sort of review, except to commend it to you (and perhaps particularly to students) as providing a birds-eye view of what is going on in Physics in Australia. The book is, however, a landmark for several viewpoints and it is on this that I would like to comment.

Many of you may not even be aware of the existence of the National Committee for Physics, which is one of the thirty or so National Committees set up by the Academy “to foster a designated branch of natural science in Australia, and to serve as an effective link between Australian scientists and overseas scientists in the same field” by membership of International unions etc.

The Physics committee does not try in any way to usurp the traditional role of the AIP but rather to cooperate and to extend this role. The Institute nominates two representatives to the Committee (Oliver Raymond and myself at present), and the Australian Acoustical Society nominates one. Naturally, the Chairman (Angas Hurst) and most of the other Committee members are usually also AIP members.

Until the last few years, National Committees have generally confined themselves to relations with International Unions, but this is now changing. A month or two ago the Academy arranged a meeting in Canberra between the chairmen of the National Committees and representatives from nearly all the scientific societies in Australia to discuss matters of common interest. Almost 60 scientific societies sent representatives. Geoff Wilson attended for the AIP, since I was there in an Academy role, and both the Chairman and the Secretary of ASTEC (Sir Geoffrey Badger and Roy Green) and a representative of the Department of Science and Technology (John Bell) were also present.

Common problems are many, and one of the most pressing is the need for scientists to speak with a strong and united voice on behalf of science and the scientific values we all accept, whatever may be our differences on matters of detail. We all hope that, through meetings such as this, we can develop the beginnings of a “Science Lobby” or at least a more effective way of dealing with the Government, the public and the media.

I hope that many of you will buy the Report and read it. It is frankly a preliminary survey, and the National Committee is now going on to consider its implications. If it provokes in you any thoughts or suggestions for action, please let us know.


Editorial
Many of us whose work includes generating information, media releases and handouts are often amazed at the apparently uncritical acceptance by the media of much of our work. It is only when we move to the other side of the editor’s desk do we realize what an awesome task confronts the modern newshunter.

The absence overseas for five months of the editor of the Australian Physicist, Dr Jim Graham, will give me an extended opportunity to experience the work that Jim has done so ably.

Like all other media, we do in fact put as much care and attention into the task as is possible under the considerable constraints of time, manpower and expectations. All papers are reviewed by both the editor and a subject expert. All reports are vetted and all handouts from the multitude of public relations departments, both Government and private, are subject to a critical blue pencil.

However, despite our sincere efforts, mistakes creep in and occasionally news items appear more than once. All this is “par for the course” for any editor, who worries his publication “to bed” each issue, and then hopes for the best. His desk is already piling up with copy for the next edition even before the present one is typeset.

This task, which I already enjoy, can be made somewhat easier by help from you, the reader. As physicists generating knowledge you have far more insight into the news than the reporter, public relations consultant or editor. Each of these people has a job because you are too busy to spend the many “non-creative” hours necessary transforming ideas into copy that can be read by a wide audience.

Your help can come by sending to me annotated information. For example, if your laboratory department or institution does produce material of interest to readers of this journal, then send it to me, with some of your own comments.

Another easy way of producing copy is to either rewrite what was written for that other medium, or ask the journalist concerned to do an appropriate rewrite for us. Of course the option of generating completely new copy for A.P. is always open.

It’s as easy as keeping a pen in your hand and a blank piece of paper by your side as you read through your particular mountain of information.

JOHN BARKER
The Australian Physicist, Vol. 19, June 1982 — Page 89
THE CASE OF THE DISAPPEARING DINOSAURS

Clifton L. Smith, Science Department, Nedlands Campus, Western Australian College of Advanced Education

INTRODUCTION

Sixty-five million years ago the reptilian species of animal, collectively known as dinosaurs, disappeared from the planet Earth. Dinosaurs inhabited this planet for a duration in excess of one hundred million years during which they were the earth's most dominant species. This time vastly dissected into smaller units and the dinosaurs became widespread and diverse. However, in a relatively short period in geological terms — some believe as short as 50 years (Smit and Hertogen, 1980), and certainly less than 10,000 years (Hsu, 1980). Not only did the many species of dinosaur vanish from quite different biota environments all over the globe, but it has been estimated that up to 75% of all living species on Earth perished during this time (Russell, 1979). Such a catastrophic event in the history of the evolution of life on this planet has recently been viewed in terms of a strata "trigger". It has been argued that such large scale biological stresses necessary to produce the observed effect of gross extinction could not originate on the planet itself without remnant evidence remaining. This discussion seeks to examine possible extraterrestrial sources for the dislocation which so violently disrupted the evolution of species on Earth.

During the 570 million year period for which fossil records are available, thus indicating species occupation of the planet, five catastrophic biological crises have been responsible for the extinction of large numbers of species (Alvarez et al., 1980). The most recent instance of large scale extinction defines the geological periods of Cretaceous and Tertiary about 65 million years ago. The Cretaceous-Tertiary (C-T) boundary seems to be the only major boundary in the stratigraphic record which does not become diffuse when studied in detail (Russell, 1979). This boundary has been found as a single bedded plane at sites scattered over the world, varying in thickness from a few to about ten millimeters. The boundary layer between the C-T periods was laid down at exactly the time of extinction of a majority of species on the planet. The link between the C-T layer and a catastrophic extinction event seems highly probable.

Current extinction models may be classified as gradual or terrestrially induced, and catastrophic or extra-terrestrial in origin. Terrestrial models include (i) nutrient depletion, (ii) climate deterioration, (iii) CO$_2$ -- O$_2$ imbalance, (iv) natural variations, and (v) an increase in volcanism, all being essentially gradual in mechanism with precursor evidence of extinction being available in the sediments prior to the event. Catastrophic hypotheses proposed to explain the terminal Cretaceous extinctions include (i) spillover of the Arctic ocean induced by extra-terrestrial radiation, (ii) magnetic reversal, (iii) radiation from a nearby supernova event, with dust injected into the atmosphere, (iv) meteorite or comet impact on the planetary surface, and (v) solar flare irradiation. These extra-terrestrial triggers for the extinction phenomenon would provide no "forward indicators" in the strata prior to the event, as seems to be the case from stratigraphic evidence of the C-T boundary material.

Ir and Os ANOMALY

The C-T boundary layer has been thoroughly studied over the years, but only in very recent times have elemental and isotopic abundance measurements been made on this very thin layer (for example, Alvarez et al., 1980; Smit and Hertogen, 1980; Ganapathy, 1980). Smit and Hertogen (1980) performed analyses of trace elements in the 5mm C-T sedimentary layer of south-east Spain using neutron activation techniques. They found that this layer was much richer in the elements iridium and osmium when compared to the strata just below and just above it, with the enrichment factors for the Ir and Os about 450 and 250 respectively. However other elemental enrichments were also observed (Co, Ni, Cr, Se and Sb) but were not believed to be anomalous as the enrichments may be derived from terrestrial source rocks. But a similar origin for the anomalous iridium and osmium could not be claimed as these elements are greatly depleted in the crust of the Earth with respect to Solar System values, and are generally much less than 1 p.p.b. in concentration. Almost simultaneously Alvarez et al (1980) announced a 30 fold increase in iridium concentration from a "fish clay" layer separating Cretaceous and Tertiary limestone beds near Gubbio, Italy. No enhancements were found for any of 27 other trace elements, though the analysis did not include osmium. Again this research group has determined a 160-fold enrichment of iridium form the C-T boundary layer south of Copenhagen, Denmark. As Smit and Hertogen (1980) claim that the 5mm thick transition layer between C-T represents sediment deposition within 200 years, then these anomalously elemental abundance determinations appear to be clearly linked with an extinction event which was extremely abrupt.

The Ir and Os enrichments have given strong support to the extra-terrestrial hypotheses for the extinction mechanism (Alvarez et al., 1980). The most favoured catastrophic models which have no pre-extinction evidence are (i) a large meteorite or asteroid impact, (ii) a micro comet collision, and (iii) the occurrence of a supernova event within 50 light years.
of the Solar System (Tucker, 1977). Each of these models will be discussed in terms of the Ir and Os anomaly.

LARGE METEORITE

The asteroid impact hypothesis seems to satisfy most of the biological and physical evidence. It required a large asteroid forming a huge impact crater. Much of the dust ejected from the crater was flung into the stratosphere spreading round the globe. This dust in the atmosphere attenuated the sunlight to such an extent that the plant was shrouded in darkness for several years, suppressing photosynthesis and disrupting food chains. An environmental crisis was maintained until the dust settled — with the sedimentation layer containing relics of the vaporised asteroid. It is interesting to note that an asteroid of diameter 10 km and impact velocity of about 25 km.s⁻¹ would liberate kinetic energy approximately equivalent to that of 10⁴ megatonnes of TNT. The largest terrestrial explosion which has been well recorded was the destruction of the island volcano Krakatoa on August 26 and 27, 1883. Approximately 18 km³ of material was erupted into the atmosphere, of which about 4 km³ reached the stratosphere where it stayed for about 2 years. Although the Krakatoa explosion is dwarfed by a 10 km diameter asteroid impact, it still remains a useful model upon which to quantify a meteorite impact crater scenario.

Alvarez, et al. (1980) have estimated the size of the impacting meteorite in several ways. The Ir enrichments in the Italian sections were assumed to be derived from a CI carbonaceous chondrite meteorite. Using known Ir concentrations in CI chondrites (Krakenh believed, the amount of Ir deposited in the C-T layer, and a distribution factor derived from Krakatoa data, an estimate of the diameter of the meteorite was derived. Then, from the volume of sediment in the C-T layer an estimate of size of the meteorite was possible, as a knowledge of the amount of light attenuation needed to “shut-off” photosynthesis can allow an estimate of the quantity of dust in the stratosphere. So Alvarez et al. concluded that convergent evidence indicated the meteorite to be about 10–4 km in diameter.

Also Ganapathy (1980) has recently completed an extensive elemental abundance survey of “fish clay” in the C-T boundary layer. Neutron activation techniques were employed to examine abundances of noble metals (Ir, Os, Au, Pt, Rh, Ru, Pd, Ni and Co) in Denmark C-T sedimentation, together with sample analyses from regions both above and below the boundary layer. Ganapathy (1980) described a close resemblance between the abundance patterns of noble metals in the clay and CI chondrites which represent cosmic abundances, and claimed this close correspondence to be the most direct evidence for the presence of meteorite debris in the C-T boundary layer.

A recent report from Smith and Klaver (1981) disclosed the discovery of spherules in the C-T boundary clay at Carvaca, Spain. The numerous spherules were composed of finely crystallised almost pure K-feldspar, and are thought to be derived from the solidification of a melt probably produced by an impacting body. However chondritic meteorites have low K-feldspar content, which poses a problem for identification of the impacting body: however some iron meteorites contain sufficient K-feldspar to produce the discovered spherules. Another possibility is that the feldspar was derived from cometary material, although K-feldspar is a differentiated mineral and does not occur in undifferentiated Solar System material such as chondritic or cometary sources.

COMET

Hsu (1980) claimed that a comet is the most likely cause for the C-T extinction. He noted that while large animals and particularly oceanic species were destroyed, there is evidence for a gradual evolutionary change in terrestrial vegetation and small fresh water animals. Hsu argued that a global dust cloud would be expected to affect all species, so that a more selective extinction hypothesis is needed. A comet about the size of Halley’s comet (estimated to 10⁵ tonnes) would produce large scale devastation with an impact on Earth. Sufficient energy would be released to either heat the atmosphere by 190°C, or heat the top 100m of the oceans by 5°C, or vapourize about 4 x 10⁸ km³ of ocean water. The thermal stress from such an impact caused all animals greater than 25 kg to die (Russell, 1979), and ocean heating together with large amounts of hydrogen cyanide and methyl cyanide (as detected in Comet Kohoutek) injected into the oceans was sufficient to poison marine life. If the concentration of cyanides in the comet was 10%, the amount of cyanide dissolved from a 10⁴ kg comet produced a concentration of 0.1 p.p.m. if homogeneously distributed in all ocean water. However this concentration would increase to 3 p.p.m. if restricted to the upper 100m of the oceans.

Finally Hsu (1980) argued that at least one comet of the necessary size should have collided with the Earth sometime during the Phanerozoic era (the past 600 million years) since well developed plants and animals evolved. Although the crater from such an impact has not been found, it was most likely formed in the ocean floor and has since been returned to the mantle by subduction.

Smith and Klaver (1981) tend to support the comet hypothesis by elemental enhancement measurements in the C-T boundary layer for the chalcophile elements As, Se and Sb. Comets are thought to be primitive entities of the Solar System, being essentially undifferentiated with volatile components being preserved. The presence of anomalous chalcophile and moderately volatile elements like K, As, Se, Sb and Zn seem to indicate a source of cometary origin.

SUPERNOVA

The speculation that a nearby supernova event was the extra-terrestrial “trigger” for C-T extinction of species has been discussed for more than 40 years (for example; Terry and Tucker, 1968). The frequency of supernova events has been described by Tucker (1977) where he discussed the probability of a supernova occuring about every fifty years in a galaxy (Tammann, 1970), and having a reasonably strong association with the galactic spiral arms. The probability of a supernova explosion near to Earth varies with the position of the Sun in the Galaxy. Almost every 50 to 100 million years the Sun passes through a spiral arm taking about 10 million years to make the passage, during which time the Sun will be in proximity to dense star associations containing massive stars that will eventually undergo supernova.

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moon soil contains an enhancement of elements contained in chondritic meteorites, including Ir and Os. The hot relativistic expanding shell of a supernova possesses sufficient energy to eject large amounts of lunar soil at velocities in excess of the escape velocity. Ruderman and Truran (1980) contend that the expelled lunar surface soil should be characterised by an Ir abundance which is greatly enriched relative to terrestrial base rocks.

A FURTHER TEST

The discovery of elemental enhancements, particularly Ir and Os, has provided an exciting new chapter in the interpretation of the paleoenvironmental conditions at the time of the demise of the dinosaurs. From the evidence examined so far, no clear cut alternative for the explanation of the C-T extinction appears to be available. However, the problem could be further illuminated with a study of fish clay samples from the C-T boundary layer by an elemental and isotopic survey for the chemical element tellurium.

Like the elements As, Se, and Sb for which enrichments were found in the C-T layer (Smith and Claver, 1981), Te is also chalcophile and is chemically most similar to Se. Then it would not be surprising for an enhancement of Te to be found in the fish clay layer containing the Se enrichment. A study of the isotopic abundance of Te in the strata of interest could permit a reassessment of the mechanism for the extinction phenomenon.

The element tellurium has eight stable isotopes at mass numbers 120 (p-process), 122, 123 and 124 (s-process), 125 and 126 (r-process), and 129 and 130 (r-process). The r-process isotopes of 134Te and 135Te are produced in a supernova event (Heymann and Dziczkaniec, 1981) such as the remnants of the Vela and Crab nebulae. The relatively high abundance of 135Te and 136Te has been described by Smith (1982) as an excellent indicator of supernova remnants in terrestrial samples.

Within the Solar System elemental Te is moderately abundant with a cosmic abundance of 2.34 p.p.m. estimated from the CI carbonaceous chondrite Orgueil (Smith et al., 1977); the concentration of Te in base rocks is typically at the p.p.b. level for basalts and granites (Smith et al., 1977). Because of the relatively high enhancement of Te in chondritic meteorites when compared to base rocks, then if the C-T boundary layer contained relics of a chondritic meteorite an enrichment of Te could be expected with an isotopic abundance ratio the same as terrestrial Te (Smith et al., 1978). Similarly an iron meteorite containing the chalcophile elements of S, Se and Te would also display a normal isotopic abundance of Te from the sedimentation strata.

Although Feldman (1977) indicated that there was no present compelling astronomical evidence to favour the supernova trigger hypothesis, he conceded that it was statistically possible for such an event to have occurred. Then the possibility that the C-T extinction was caused by a supernova event can be tested by an isotopic analysis for 135Te and 136Te.

Conclusion

The demise of the dinosaurs still remains a mystery to be solved. The most recent set of hypotheses, established around extraterrestrial intervention, provide clues for possible mechanisms of the extinction process, with the Ir and Os enrichments of the
sedimentation in the C-T boundary layer being a major discovery. But over the geological time while species have inhabited the Earth, five definite extinctions are known, so that a re-occurring source of diacostion is necessary. However, the problem of reconstructing the extinction event 65 million years ago from the relics remaining today remains an intriguing test of scientific skills.

REFERENCES

Letter

Australian Optical Microscopes

While writing the biography of the late John McNeill, formerly of CSIRO Division of Chemical Physics, I became aware that after the 1939-45 war a very significant effort was invested in the production of optical microscopes in Australia. They were used in the teaching of the large undergraduate classes in the Universities in the post-war years. Two microscopes were designed and made, one designed by McNeill and G.G. Schaefer and made at the Ordnance Factory in Melbourne and the other by the Australian Optical Company, the Melbourne firm of L.D. Colechin. The story of these microscopes is a continuation of Australian work on optical munitions given in the book by D.P. Mellor, Australia in the War of 1939-1945; Series 4, Volume 5, the Role of Science and Industry (1958).

Through the kindness of Mrs S.M. Peters, a collection of most of the parts of a "Colechin" microscope was given to me. These parts have been assembled into a full microscope in the Physics workshops at Monash University by Mr Ken Nuske, who had done some of his training in optical instrument making at Melbourne University during the War. This Colechin microscope is presented to the Museum of Medical History at Melbourne University which is in the charge of Emeritus-Professor Ken Russell; this is a most suitable place for it.

I have handled one of the Ordnance Factory microscopes which I might call the "McNeill-Schaefer" microscopes and I think that it would be very appropriate also to see that one of them is offered to the Museum of Medical History. Five hundred were made. There might be a reader of the Australian Physicist who knows where there is one, I should be most interested to hear from any reader who can help me.

H.C. Bolton
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Erratum

Some scrambling occurred in editing Professor B.M. Spicer's introduction to "Chadwick and the Neutron" in the April issue (P. 50). It should read as follows:

While a member of the Cavendish Laboratory, he was the first to make a study of deuteron-induced reactions, and to identify tritium and ^He as products of the deuteron-deuteron reaction. Later he directed the installation of the High Tension Laboratory there.

At the University of Birmingham, he directed the laboratory which made very major contributions to radar, through the invention and development of the 10 cm magnetron. A service which certainly enabled radar to be carried in aircraft, as well as increasing markedly the precision of land-based radar. Post war, he directed the design and construction of a 1000 MeV proton synchrotron.

Editor

ANU Annual Report

The ANU's 1980 Annual Report received a special mention in Federal Parliament last month when Senator M.J. Macklin (A.D. Qld) said the university had "taken some trouble" in the presentation of reports of the results of research work. 'It has presented these reports in a manner which is intelligible to the layman,' he said. 'This is an essential element which has been missing from many university reports to date.'

Senator Macklin said that all too often in a discussion of universities in Australia the phrase 'ivory tower' was used. 'The report of the Australian National University has made it much more clear that ivory towerism is not operating there,' he said. 'The University has had a very great involvement with, and makes a great contribution to, the general public and to the Government.'

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High-Power UV Rare Gas Halide Lasers for the Laboratory

D.A. Scott, G.R. Mackellar and J.A. Piper, School of Mathematics and Physics, Macquarie University, North Ryde, N.S.W. 2113.

Perhaps the most exciting development in lasers in the past decade has been that of the rare gas halide (RGH) excimer laser systems. The RGH lasers are characterised by high-power (tens to hundreds of megawatts), high-efficiency (1-4%) pulsed emission at wavelengths in the ultraviolet as low as 175 nm. Of the various possible RGH combinations, the most important are XeF (353 nm), XeCl (308 nm), KrF (249 nm) and ArF (193 nm). These laser devices have wide application in photochemical processing, including isotope separation and purification of chemical compounds, lithography, remote sensing and many other physical techniques. A RGH laser is an invaluable asset to any physics, chemistry, biology or engineering laboratory, particularly as a tool for the investigation of various atomic and molecular processes. This paper describes a RGH laser we have made and gives some details of its operation.

The active medium of a RGH laser consists of a high-pressure (up to 3-4 atmospheres absolute) mixture of the active rare gas (Xe, Kr or Ar), a halogen donor gas (usually F, NF, or HCl), and a rare gas buffer (He, Ne or Ar), with the active components usually amounting to only a few percent of the mix. Laser transitions originate from bound ionic excited levels, the lifetimes of which are a few tens of nanoseconds, and terminate on repulsive or weakly bound ground states of the molecules. The lifetimes of the molecular ground states are typically less than 10^{-12} seconds. Efficient population of the upper laser level is achieved via collisional transfer of energy from donor species generated in the laser mixture by either electron beam or electric discharge excitation. The two most likely reactions resulting in population of the RGH excimer upper laser levels are third-body assisted ion-ion recombination,

\[ X^+ + Y + M \rightarrow (XY)^+ + M, \]

and the "harpoon" reaction

\[ X^* + Y \rightarrow (XY)^* + Y, \]

(X, active rare gas; Y, halogen donor; M, buffer gas). These reactions represent only the final steps in a whole series of reactions in the complex gas mixtures typical of the RGH lasers and it is uncertain which predominates. The substantial ion densities formed in e-beam pumped RGH mixtures favour the first reaction; the second is generally believed to be of greater importance in discharge-excited devices. (For detailed discussions of excitation mechanisms and performance of various RGH laser systems the reader is referred to excellent reviews by Rokni et al. (1978), Eletskii (1978) and Sze (1979).)

Although e-beam devices generate the highest pulse energies (> 1 kilojoule per shot has been reported), discharge-excited RGH lasers are the more appropriate to (up to 3-4 atmospheres absolute) general laboratory use. 'Bench-top' discharge devices with output pulse energies approaching 1 J and mean powers up to 20 W at pulse repetition frequencies ~100 Hz are now readily available on the commercial market. Indeed construction of small discharge-excited RGH lasers giving pulse energies in the 100 mJ range at low repetition frequencies is well within the capabilities of most physics and engineering departments. For the past two years we have operated such a RGH laser, built in our laboratory from a design (based on that of Andrews et al. (1977)) which emphasises the use of locally available components. A photograph of the laser is shown in figure 1.

Figure 1: View from above of the rare gas halide laser built and operating at Macquarie University, showing laser tube and gas handling console.

This device incorporates a fast transverse electric discharge with uv-preionization of the active volume by a linear flash array ensuring discharge homogeneity. The main body of the discharge vessel is a 1 m length of heavy-wall, 15 cm diameter QVF glass tube terminated with PVC flanges. The electrodes consist of a pair of parallel aluminium bars, the upper (cathode) of semi-circular cross-section and the lower (anode-earth) of rectangular cross-section,

Figure 2: Schematic cross-section of the laser vessel.
each of length 80 cm, supported by aluminium plates and separated by 30 mm (figure 2). The linear flashboard, made of closely spaced stainless steel segments arranged along 9 mm (o.d.) pyrex capillary with a coaxial earth return lead, runs the length of the discharge region. An array of ‘dump’ capacitors (21 x 920 pF, Murata type DHS38 Z3V 921 Z40) is arranged in parallel with the electrodes, internal to the discharge vessel. The discharge circuit is illustrated in figure 3. Storage capacitors C, and C, (0.02 μF and 0.05 μF respectively, Maxwell types 31247, 31173) are charged to 30-40 kV. When spark gap S is triggered, C, discharges directly into the flashboard F which provides uv irradiation of the laser mixture for preionization purposes. Simultaneously capacitor C, discharges into the ‘dump’ capacitor array C, which in turn rapidly deposits energy in the active volume when breakdown occurs across the main electrodes, some 200 ns after the preionization flash.

![Figure 3: Discharge circuit for the RGH laser.](image)

The gas handling system associated with the laser consists of stainless steel and brass ‘SwageLock’ fittings and permits mixing of three gases in variable proportion to a maximum pressure of 2500 torr. Only static gas fills are employed.

The laser mirrors, which must be made of high-quality fused silica (‘Suprasil’) for efficient transmission at short wavelengths (193 nm for ArF), are mounted on o-ring seals in the end flanges and form part of the high-pressure vessel. Reflecting films are on the back faces of the mirrors (i.e. external to the vessel) to avoid damage by the corrosive gas mixture. In common with a number of designs from the literature we employ a broadband (aluminised) high-reflecting mirror, radius of curvature 4m concave, at one end of the cavity, and an uncoated (92% transmitting) flat blank as the coupling mirror at the output end.

All the components used in the construction and assembly of the laser are readily available in Australia, with the exception of the high-voltage capacitors C, and C, (which were obtainable through Australian agents, however). The component cost excluding the power supply is estimated at $4,000. Of the various gases required for operation, Ar, He and HCl are stock items in Australia (CIG), while Kr, Xe and F, (in dilute form mixed with He) must be imported.

Prior to operation the laser vessel must be passivated with fluorine (or hydrogen chloride), a procedure which involves filling the device to about half an atmosphere (absolute) with an enriched F, (or HCl) mixture (2% in He) for aperiod of 48 hours. After passivation the laser vessel is evacuated then refilled with the appropriate laser mixture: in the case of ArF, for example, Ar 6.4%, F, 0.3%, He 93.0% at a total pressure of 2000 torr (see Table 1).

We have successfully operated this laser with three RGH combinations. Typical of these is ArF from which we have obtained 14 ns (FWHM) pulses at 193 nm with energies of around 80 mJ and peak powers almost 6 MW with a charging voltage of 30 kV. Table 1 summarises the performance of our RGH laser on the three systems tried to date. (The data presented were obtained for a charging voltage of 30 kV; however recent upgrading of the power supply to 40kV has improved output energies by factors from two to four.) The shot life of the laser when fully passivated is around 40 minutes at a pulse repetition frequency of 0.5 Hz with a shot-to-shot reproducibility of better than ±10%. The lifetime can be expected to improve with the provision of simple gas recirculation and filtering facilities.

We have operated this laser reliably for over two years with only minimal maintenance: replacement of the internal capacitors, cleaning of aluminium electrodes and polishing and recoating the laser mirrors. During this period we have employed the laser to investigate the kinetics of various atomic and molecular processes by photodissociation of simple molecules. Of particular interest have been experiments with photodissociation lasers in which we have observed high-power laser action on the B → X band of HgBr and on resonance transitions of atomic sodium and thallium. In the latter case 300 kW pulses on the green λ 535.0 nm line of TI were obtained by photo-dissociation of TI1 vapour by the uv output of the ArF laser. Experiments investigating frequency down-conversion of the uv output of the RGH laser using Raman shifting techniques are also in progress.

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<td>8 ± 1</td>
<td>50</td>
<td>6.3</td>
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"NEAR ZERO — New Frontiers of Physics"

Stanford University, California, USA. March 25-27 1982.

In the field of low temperature physics the bold, almost impossibly difficult but fundamentally important, experiment brings to mind the name of William M. Fairbank. In his honour, and to celebrate his 65th birthday, a conference titled "Near Zero" was recently held at Stanford with about 20 distinguished invited speakers and some 30 contributed papers and posters. (In October 1976, during a three week visit to the Physics Department at the University of Western Australia, Professor Fairbank delivered a lecture series entitled "Near Zero — a Frontier in Physics".)

Precise control, or sensitive measurement, of nearly any basic physical property is best achieved at low temperatures. It is not merely that the thermal noise is reduced but that experimental benefits become available from exploiting the special properties of matter in states possessing long range quantum order, particularly those of electronic states in superconductors. Fairbank understood this only too well and over the years he and his associates have continually found new applications. Thus when he and Bascom Deaver in 1962 demonstrated the quantization of magnetic flux, originally predicted by Fritz London, it was realised that a true zero of magnetic field is conceivable and since flux is discreetly quantized, one could produce an arrangement which is at the zero level and hence carry out experiments in a truly zero magnetic field. As reported at the conference, the achievement of experimentally accessible volumes of space which do contain, if not zero, only a few flux lines, has led to the just announced apparent detection of a magnetic monopole. In the context of low temperatures, "Near Zero" might have been thought to mean the extreme cryogenic range towards the absolute zero of temperature but as a theme for this conference it implies near zero as itself an experimental concept. How near zero is it possible to reduce the magnetic field? or its fluctuations? the electric field? the gravity gradient? the temperature interval? the mechanical movement caused by seismic vibrations? etc? The papers presented described experiments whose success depends on the reduction of such fields or their fluctuations to as near zero as possible and all were closely linked with Fairbank and his work. They were given by speakers who were his associates or former students or by distinguished reviewers and the list included no less than five Nobel laureates.

Among the speakers was Professor M.J. Buckingham FAIP, Professor of Theoretical Physics at the University of Western Australia, and associate of Professor Fairbank at both Duke University and Stanford. Prior to departing for the conference he presented a seminar in the Physics Department at UWA, related to his invited paper which was titled "The shape of the Helium $\lambda$-Transition". The seminar told of his pioneering work with Fairbank at Duke University in the late 1950's on the high resolution measurement of the specific heat of helium close to the $\lambda$-point. This included a fascinating anecdotal account of the people involved in the field and others of that period.

A recent development, related to that early $\lambda$-transition work, was presented by Dr John Lipa from Stanford. Originally from Australia (he obtained his PhD from UWA in 1969) he detailed the conference the results of recent measurements of the specific heat near the $\lambda$-transition recorded with a temperature resolution of $10^{-10}$K. The thermometer, with a potential resolution of $10^{-10}$K, uses a SQUID to measure the temperature dependent field of a magnetic salt.

Through Professor Buckingham's direct association with professor Fairbank, and through a previous head of Department, Professor Roy E. Rand, the UWA Physics Department has been fortunate in enjoying very close links with Stanford and direct participation in several exciting research projects. The current gravity wave detection project is one tangible outcome of this connection. The UWA 1.5 tonne niobium bar detector is one of a quartet of time-linked detectors, the other three (aluminum bars) being at Stanford, Rome and Louisiana. Progress in this field was the subject of several conference papers, including invited talks by E. Amaldi (University of Rome) and W.O. Hamilton (Louisiana State University).

The conference proceedings will make fascinating reading with progress reports on very varied experiments: the superconducting fractional charge experiment, using microscopic niobium spheres and the observation of charges $1/2$; the free fall of electrons in a region free of electric fields; tests of general relativity with a satellite-borne superconducting gyroscope; free electron lasers; the production of spin polarized beams of atoms and particles and their use as probes in scattering experiments. These are just a few of the topics which catch the eye and imagination on scanning the program.

On his return, Professor Buckingham presented a second seminar in the UWA Physics Department to report experiments by B. Cabrera at Stanford on the detection of magnetic monopoles by observing the step change resulting in the persistent current in a superconducting ring when a monopole passes through it. This is a wonderfully simple and elegant detector in which the change of the otherwise constant flux through the ring depends only on the passage of a monopole and is independent of its velocity, electric charge, mass, dipole moment etc. The Stanford experiment has now been recording for some months and has detected a number of small events which can be interpreted as monopoles passing near the ring and leaving flux trapped in the magnetic shield. One single very convincing event fits closely

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the predicted signal for the passage of a single Dirac monopole actually through the ring. This experiment relies on the creation of a magnetic field free environment for the detector ring and the "near zero" fields (\( < 5 \times 10^{-6} \) gauss) are produced by expanding a concentric series of superconducting lead "balloons" to reduce the trapped flux density. This technique was developed for the superconducting satellite-borne gyroscope experiment in which both Dr Lipa and Dr Frank van Kann (another UWA PhD graduate, now returned to WA) were involved at Stanford. The preliminary results of the monopole experiment have been submitted to Physical Review Letters and are sure to provoke intense interest and no doubt controversy in the world Physics community.

The West Australian and Australian Physics community is fortunate to have been represented by one of only three or four overseas participants at this distinguished meeting and we look forward to further fruitful and interesting results from our links with Stanford.

R. SEVERIN CRISP (W.A. Branch Correspondent) with thanks to M.J. Buckingham for his help in producing this article.

PEOPLE

The Council of the Royal Astronomical Society, U.K. has elected Professor K.D. (Keith) Cole an Associate of the Society in recognition of his "outstanding contributions to geophysics". Professor Cole is well known in his field for his theories of phenomena in the upper atmosphere, ionosphere and magnetosphere. He has been President of the Scientific Committee for Solar-Terrestrial Physics since 1977 and President of the International Association of Geomagnetism and Aeronomy since 1980. At La Trobe University he is Head of the Division of Theoretical and Space Physics and currently the Chairman of the Physics Department.

He was recently awarded a Research Associateship of the National Science Foundation U.S.A. and he will spend one year working at NASA, Goddard Space Flight Center, U.S.A., commencing in June 1982.

At the annual meeting of the Academy of Science in Canberra in April five scientists were honoured by the award of medals.

Professor R. Hanbury Brown, FAA, FRS, School of Mathematics (Astronomy), University of Sydney, was presented with the Matthew Flinders Medal and delivered the Flinders Lecture which was entitled: Measuring the Size of Stars.

The Matthew Flinders Lecture is one of the most prestigious awards of the Academy. Professor Robert Hanbury Brown was a pioneer in radar research before World War II, and in radioastronomy after it, working with Sir Bernard Lovell on the development and construction of the Jodrell Bank telescope, at that time by far the largest in the world. Since 1964 he has occupied the Chair of Astronomy within the School of Physics at Sydney University. The Narrabri interferometer which he built was used to measure the angular size of 32 stars, making a major contribution to astronomy.

Professor D.W. Robinson, FAA, Department of Mathematics, Institute of Advanced Studies, Research School of Physical Sciences, Australian National University, was presented with the 1981 Thomas Ranken Lyle Medal which is awarded for distinguished research in mathematics and physics.

Professor Robinson has made substantial contributions to the understanding of the evolution of quantum mechanical systems near equilibrium.

Dr M.A. Green, School of Electrical Engineering and Computer Science, University of New South Wales was presented with the 1981 Pawsey Medal and Associate Professor J.A. Piper, Department of Physics, School of Mathematics and Physics of Macquarie University was presented with the 1982 Pawsey Medal.

The Pawsey Medal recognizes outstanding research in experimental physics by a scientist under the age of 35 years.

Dr Green was awarded the 1981 Pawsey Medal for a series of important investigations into the physics and device applications of silicon metal-insulator-semiconductor (MIS) structures.

Professor Piper was awarded the 1982 Pawsey Medal for his contributions in the field of laser physics.

The Pawsey Medal commemorates the unique contributions to science in Australia by the late Dr J.L. Pawsey, FAA.

Associate Professor Alan McIntosh, School of Mathematics and Physics, spent his study leave and long-service leave from July 1980 to May 1981 in France and the United States.

While on leave Professor McIntosh, together with Y. Meyer (Ecole Polytechnique) and R. Coifman (Yale University) solved a longstanding conjecture of Zygmund and Calderon. In his report he said the work introduced the new concept of compatability of Hilbert space operators.

"The concept of compatability is new and exciting, and hopefully will lead to the solution of a variety of problems in partial differential equations."

Other topics he studied on leave included the perturbation of spectral subspaces of self-adjoint operators, the representation of sesquilinear forms using square roots of accretive operators, and properly elliptic boundary value problems with discontinuous coefficients on irregular domains.

During study leave he also collaborated in a number of papers, gave colloquia and attended conferences.

Macquarie University News

At the annual meeting of the Academy of Science in Canberra Professor A.J. Birch, recently retired from the chair of Organic Chemistry, Research School of Chemistry, Australian National
University, was elected President of the Academy for a four-year term. He is a Fellow of the Royal Society. Professor Birch is well known for his work on the organic chemistry which contributed to the development of the contraceptive pill.

Professor B.W. Holloway, Department of Genetics, Monash University, Melbourne was elected Secretary (Biological Sciences).

The following were elected to the governing Council of the Academy: Professor J.W. Lance, Chairman, Department of Neurology, The Prince Henry Hospital, N.S.W.; Professor C.B. Osmond, Department of Environmental Biology, Research School of Biological Sciences, Australian National University; Professor F.D. Stacey, Professor of Applied Physics, University of Queensland.

Also ten Australian scientists were elected to join the Fellowship of the Australian Academy of Science.

The honour of Fellowship is conferred upon scientists for distinguished contributions by research to the advancement of the natural sciences. A few places are reserved for those who have served science in other ways.

They are: Alexander Boden, founder and Governing Director of Hardman Chemicals Pty Ltd and of Science Press; Richard Peirce Brent, Professor of Computer Sciences in the Faculty of Science at the Australian National University; Jacob Nissim Israelachvili, Senior Fellow in the Department of Applied Mathematics of the Research School of Physical Sciences of the Australian National University; John Francis Lovering, Professor of Geology in the School of Earth Sciences in the University of Melbourne; Ian Ellery McCarthy, Professor of Physics in the Flinders University of South Australia; Angus David McCowan, Chief of the CSIRO Division of Oceanography, Hobart; Allen Forest Reid, Chief Research Scientist in the CSIRO Division of Mineral Chemistry, Melbourne; Wilfred John Simmonds, Professor of Physiology at the University of Western Australia; Norman Alan Walker, Associate Professor of Biology in the School of Biological Sciences in the University of Sydney; Wesley Kingston Whitten, Research Associate in the Department of Zoology in the University of Tasmania.

The retirement from the CSIRO Division of Applied Physics of Mel Thompson marked the end of an era for the laboratory. Mel was the last of the original nine scientists of whom the National Standards Laboratory was originally constituted. Mel joined the Lab after graduating with honours in physics from the University of Adelaide, and over the years he made major contributions to his scientific discipline, including capacitance metrology and resistance measurement with particular application to resistance thermometry. Mel’s work has been honoured by the Sperry Award, which he shared in 1965 with Doug Lampard, his election as the Fellow of the Australian Academy of Science in 1972, and the Morris E. Leeds Award in 1977 for outstanding contribution in the field of electrical measurement.

Mel will continue to work as an Honorary Senior Research Fellow until the middle of the year when he will go to the U.S. to deliver a paper on the precise calibration of ratio transformers.

This year is not one of quiet retirement for Fred Lehaney, the former Director of the National Measurement Laboratory. He has recently had the task of chairing the Organizing Committee for the 52nd ANZAAS Congress, which was held at Macquarie University in May.

The last 12 months have seen Mr Lehaney raising funds, chairing meetings, solving problems and attending to the hundreds of details which are part of Australia’s largest science conference.

Apart from leading overseas speakers, many CSIRO researchers took part in Congress: organizing, convening, chairing, and speaking.

According to Mr Lehaney, Australia is one of the most highly urbanized societies, experiencing crippling problems of unemployment and inflation common to most western nations.

‘At the same time we find ourselves rich in mineral resources in a resource-hungry world. What is our attitude to our nation’s resources? What is industry’s attitude?’

The Assistant Chief of the Division of Applied Physics, Dr Bill Blevin, has unanimously been elected to the International Committee for Weights and Measures (CIPM).

The Committee is composed of 18 eminent scientists and metrologists of different nationalities, chosen from the 45 countries that are signatories to the Convention of the Metre. These members are appointed in a personal capacity and not as representatives of their countries.

Mt Stromlo helps Student Win Prize

The Mt Stromlo Observatory’s educational program for secondary students helped a Canberra student, Richard Watts, formerly of Copland College, win a prize in the annual Science Fair last year. Richard used Mt Stromlo’s Oddic telescope and a smaller 8cm telescope at his home for an in-depth study of the Galilean Satellites of Jupiter. The work won first prize in the scientific inquiry section of the fair, which is run by the Science Teachers of the ACT with help from the Academy of Science and other supporting bodies. Richard collected data, including observations and measurements over more than four months, to calculate, among other things, very accurate periods for the moons and the diameter of Jupiter. He also obtained a very good value for the speed of light. He is now studying Chemical Engineering at Sydney University.
Australian Space Science at the Crossroads

By Jane Brooks

Jane L. Brooks is a housewife and mother who is also a science student and a member of several space science societies. She prepared this article in the belief that the projects discussed are essential for the future of a strong Australia.

We all know the problems of funding for science in today's world, and should do what we can to ensure that the man in the street, as well as the man in Parliament House, can see the relevance of our work to industry, to education, to the economics of the future and to our everyday life. You may wish to take appropriate action concerning the projects discussed here.

— Ed.

In his article "Space Astronomy in the 1980's — Australia's Role?" Professor D.S. Mathewson, Director of the Mount Stromlo and Siding Spring Observatories writes:

"I believe that Australia is snoozing in blissful oblivion to the Space Age, and that we are soon in for a rude shock when Space Age science and technology developed by other countries puts us into the Scientific Third World."

It is unlikely that there would be anyone in Australia who would wish the above fate upon our nation. Fortunately, it is avoidable, especially if our Federal Government can be persuaded to make funds available for one Space Astronomy project and one Radio Astronomy project, which will put Australia at the forefront of Space Science. The two projects are "STARLAB" and the "AUSTRALIA TELESCOPE". The following explanations of the projects and their usefulness to Australia will, I hope, help readers to understand why it is essential that they receive support from the Federal Government.

Australia Telescope

Following World War II, Australian scientists were amongst the pioneers of the new science of Radio Astronomy. They possessed sufficient expertise to attract funds from other countries, such as the USA, enabling instruments such as the Parkes 64m diameter radio telescope to be built here. As a result, many of the most significant discoveries in Radio Astronomy have been made by Australian scientists. Now, the Parkes Radio Telescope is twenty years old, and has been surpassed in sensitivity and resolution by newer instruments belonging to other nations. There is also the emerging problem of proposed extensive copper mining near Parkes, which will threaten the "low noise" environment. If nothing is done to update present facilities and build new ones, the instruments now existing will run down due to age in five to seven years.

To overcome this, it has been proposed that a 6km long array of 22m diameter dishes be built at Culgoora, NSW. This array would be used in conjunction with the Parkes Radio Telescope, NASA's 64m dish at Tidbinbilla Deep Space Communication Complex, and a smaller antenna at Siding Spring. If this project can be started in 1982, it will come into operation in 1988 in time for our Bicentennial Celebrations. This project has been named "AUSTRALIA TELESCOPE" because it is a totally Australian project with an Australian manufactured content of 80%. It draws on expertise that is already acknowledged by the rest of the scientific world as being at the forefront in all relevant areas. This expertise has already produced "INTERSCAN", the new microwave landing system for aircraft which was developed here by the CSIRO Division of Radiophysics.

The major part of the "AUSTRALIA TELESCOPE" will be built here in Australia, thereby introducing Space Age technology to our industries. This will help to give our Nation a soaring jump into its Third Century; not only because of probable exciting discoveries in Radio Astronomy, but also because of spin-offs to space communications technology.

Australia now has the opportunity to build a World class instrument in the field of Radio Astronomy. It will be World class because of the linkup between radio antennae across the country, by satellite and ground links, giving detail finer than any optical telescopes; whether it is on the Earth or in Space. It would have a higher resolution, operate at a higher frequency, and have superior performance for spectral line observations than the Very Large Array in the USA. It would be the only instrument capable of making high quality maps, at radio frequencies, in either Equatorial or Southern regions of the sky. It would complement the excellent ground based optical telescopes already existing in Australia and Chile, and also Space telescopes observing in the X-ray, Ultraviolet and Infrared bands. Without the "AUSTRALIA TELESCOPE", the Southern sky, which contains some of the most exciting astronomical objects such as the nearest galaxies (Magellanic Clouds) and the centre of our own Galaxy, will remain uncharted at accuracies required for future astronomy. Valuable work such as studying, with Radio Astronomy techniques, the stability of the Australian continent and the drift of our neighbours New Zealand, Papua New Guinea and Antarctica also will not be done.

STARLAB

An Australian-Canadian-USA Free-Flying UV-Optical Space Telescope

STARLAB is a unique type of space telescope designed to operate from the ultraviolet through the visible to the infrared region of the spectrum. It will be capable of high resolution imagery and the
spectroscopy over a wide field of view. The length of STARLAB (telescope plus instrument package) is 5 m, with an outer diameter of 1.5 m and weight 2000 kg. It will represent the ultimate in advanced technology in the electronic, optical and mechanical areas. The Space Shuttle Transportation System will place it in orbit at an altitude of 450 km, where it will telemeter the date to Goddard Space Flight Center for demultiplexing; the Australian data will be sent via the NASA link to the Deakin Telephone Exchange for distribution to the various astronomical institutions. Each mission will be of 6-12 months duration and a total of about 10 missions of observing time between Australia, Canada and the USA is $\frac{1}{5}, \frac{1}{6}, \frac{1}{7}$ for the lifetime of STARLAB.

The proposed division of responsibilities is —

(a) Canada constructs the Telescope (costing approximately $30 million).

(b) Australia constructs the initial Instrument Package consisting of a camera, spectrograph and detector system (approximately $25 million).

(c) NASA develops the Space Platform and bears the cost of the first two launches and flights on the Space Platform. This involves all services connected with launch, integration with the Platform, operation in orbit, retrieval and the ground data system.

STARLAB will be uniquely important to the solution of the central astronomical problems of our era. It will certainly be the most powerful tool of observational astronomy in the next few decades and will advance enormously our knowledge and understanding of the Universe. At optical wavelengths STARLAB will see twenty times fainter objects and one hundred times more detail than the largest of ground-based telescopes. This will enable us to look back in time to almost the moment of Creation of the Universe. STARLAB will tell us much as it looks back over some 15 billion years into our past — a past which is violent, dynamic and one of rapid evolution.

STARLAB will also measure the ultraviolet emission from the Universe which ground-based Telescopes cannot observe. This window will surpass in importance even the radio window because it contains the strongest emissions from the basic elements of hydrogen, helium, carbon, nitrogen and oxygen.

Although STARLAB is of paramount importance to scientists, it is of equal importance to Australian industry because it is a “seed” project from which the Australian space industry can grow. Without it Australia will miss the compelling challenges of the New Age and therefore will miss the whole meaning of our epoch. Australian Industry wants this stimulating challenge, judging from the dramatic response to the STARLAB Industrial Symposium, 1981.

The Australian Government has committed itself to a Space Program by its procurement of the domestic communication satellite. As the lifetime of these satellites is about seven years, replacements are required regularly. Australian Industry wishes to gain the capability to design and build the successive generations of these satellites, a financial carrot of at least $400 million per replacement.

Because of its great size and small population, Australia’s needs, both for defence and resource management (forest, crop, mineral, water and oceanographic), are peculiarly suited to satellite surveillance; one might predict that by the middle of the 21st century, Australia will have many multi-purpose satellites in orbit. Some needs will be satisfied by flying equipment on NASA’s Space Platforms similar to that planned for STARLAB. Much of this equipment will draw on the expertise gained in building the Instrument Package for STARLAB with its special systems for detecting ultraviolet, visible and infrared emissions. Australian Industry has openly stated that it sees STARLAB as a natural lead into this booming space business — hence their great interest.

STARLAB represents the greatest challenge Australian technology and science has had. Not only will there be enormous gains to be made at the very frontiers of science but it will establish Australia as a country whose industry is capable of tackling problems at the frontiers of advanced technology. In the eyes of the world and in the eyes of Australians, our national prestige will reach an all time high. The benefits to Australia are incalculable. It is doubtful whether another opportunity for Australia to participate in a project as meritorious as STARLAB will present itself in another 20 years. By that time Australia may be incapable of competing with other countries in the high technology arena. It is now or never!

The Australian Feasibility Studies of the Instrument Package of STARLAB

Professor Don Mathewson, Director of Mount Stromlo and Siding Spring Observatories (MSSSO) of the Australian National University has made a submission to the Department of Science and Technology for $3.125 million to complete by January 1984 the feasibility studies of the Instrument Package. $1.855 million of this amount would be required in Fiscal Year 1982.

Development of low level, high count rate, photon counting detectors using photon counting techniques commenced at Mount Stromlo Observatory in 1976, and these detectors have been outstandingly successful on the telescopes at Mt Stromlo and Siding Spring. More than $2 million have gone into this R & D program and NASA has acknowledged that MSSSO leads the world in this field. The concept of the Ultra-Large Format Counting Array was put forward by MSSSO to accommodate the wide field of view of STARLAB, and the Joint Science Working Group has stated that it is the “front-runner” for the detector system on STARLAB. A “bread-board” version set up in the Electronics Laboratories at MSSSO, works well and it is hoped that by June 1982, a mini-prototype will be ready for testing on the telescopes.

Since June 1981, MATRA Espace, a French space company, and the engineers and scientists at MSSSO have been producing a report on the STARLAB Instrument Package which has been widely distributed throughout Australia and the international scientific community. This collaboration was formalised on September 9, 1981, when a Memorandum of Understanding (MOU) between MATRA and the ANU for the design and development of the Instrument Package was signed. This MOU will terminate if no funds are provided for the program in the 1982 Budget.

A STARLAB Industrial Symposium held at Mt Stromlo Observatory on December 1 and 2, 1981,
gave MSSSO/MATRA scientists and engineers the opportunity to describe the technical details of the instrument package to representatives of Australian industry and Government agencies and to seek their involvement in the research, development and construction of the components of the package which lie within their area of expertise. The two day meeting was attended by 45 industrialists, 17 representatives from Government departments, 6 Government research scientists and 19 engineers and scientists from universities. Leading officials from MATRA Espace, British Aerospace, (UK) and TRW, (USA) were present. The response of this stimulating challenge to the high technology sector of the electronic, optical and mechanical industries was dramatic and already fourteen companies are working unsupported on the Phase B studies until August 1982. In addition, eleven Government Agencies and Universities are consulting on the project.

Canada's National Research Council has funded the Canadian feasibility studies for two years and NASA has given top priority to the development of the space platform and scheduled STARLAB among the first missions to be made by the platform. There are seven engineers and scientists from Australian industry, MATRA and Mount Stromlo working full-time on the project. For Australia to keep pace with the development of the telescope in Canada and the space platform in the US, however, this will need to double by August this year and rise to 21 in March next year.

The current plan is for the three countries to sign the formal commitment to the project in January 1984, in anticipation of the 1989 launch. The total cost by 1989 is expected to be $25.5 million, of which more than 75 percent would be spent in Australia.

Fortunately for us the "Memorandum of Understanding" between MATRA and the ANU has enabled the feasibility study to go ahead. However, the MOU will be terminated unless "STARLAB" receives some funds from the Federal Government in the 1982 Budget. Once again, a favourable Budget decision is essential for Australia’s future scientific and technological well being.

Acknowledgements

The information about the "AUSTRALIA TELESCOPE" and "STARLAB" has been taken from the following documents, which were kindly provided by Dr R.H. Frater, Chief of the CSIRO Division of Radiophysics, and Professor D.S. Mathewson, Director of the Australian National University's Mount Stromlo and Siding Spring Observatories.

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STARLAB INDUSTRIAL SYMPOSIUM Mount Stromlo Observatory, December 1 and 2, 1981.


Forward Step for Solar Centre

The Solar Energy Research Centre at the University of Queensland is poised to enter a new era in its research activities with the opening of $100,000 extensions.

According to the Centre's director Dr Uguer Ortabasi, the extensions to the Centre's complex will raise its potential from that of a small testing facility to a fully fledged, largely autonomous research and development centre with a greatly increased capacity to pursue well-defined long-term goals.

The extensions, funded by the University, were officially opened by the Deputy Premier, Dr Llew Edwards.

"We realise that our commitment to supply energy goes further than just building power station after power station," he said.

"We recognise that alternative sources of energy must be given an opportunity to prove their worth.

"What is happening here is a relatively unique blend of government, academic and commercial interests that is providing significant advances in the world's knowledge of solar energy."

Welcoming the Deputy Premier, the Vice-Chancellor Professor Brian Wilson acknowledged the State Government's grant of $130,000 to the Centre this year. (This compared with $50,000 last year.)

Since his appointment in 1981, Dr Ortabasi has implemented a long-term research program with the primary aim of developing solar-powered electricity generators to replace more conventional units used by consumers in remote areas.

"Between 30,000 and 50,000 families live in remote areas of inland Australia," he said.

"To provide them with power, the electricity authorities must link them with distant electricity grids, or supply independent power sources such as diesel generators.

"All these measures are relatively expensive, and they raise the overall cost of electricity to the consumer state-wide.

"When we develop economic and reliable solar-powered systems suited to local conditions, the burden of transmitting or distributing electricity, or liquid fuels to power generators, can be circumvented, reducing the real unit cost of power for consumers."

Dr Ortabasi said his interest had been stimulated by numerous enquiries received by the Centre from people living in remote areas.

University of Queensland News

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BOOK REVIEWS


Reviewed by G.F. Brand, School of Physics, University of Sydney.

Sources of infrared and millimetre wave radiation may be listed under three headings: electron tubes, solid state devices and lasers. All are represented in this volume. High power sources such as gyrotrons and optically pumped lasers and those which produce power at more modest levels such as backward-wave oscillators, IMPATT diodes and waveguide lasers are covered.

The book would be better described as a review of the state of the development of the devices (up to the end of 1978) rather than a 'personal textbook for professional engineers or scientists'. However, two chapters, those in IMPATT diode oscillators and amplifiers and on the free electron laser, do start from first principles and derive the important theoretical relationships. Each of the chapters has its own comprehensive list of references.

Although the chapter on the gyrotron, of special interest to this reviewer, is an extension of an earlier historical survey it does include a detailed account of recent Soviet theory and device development which is not readily available elsewhere. Some errors in the author's earlier accounts have been corrected.

This is the first volume of a series of six edited by Kenneth J. Button which covers infrared and millimetre wave components, techniques and applications. The authors are all distinguished in their fields and, in a number of instances, they are associated with the device manufacturers.

The series is complemented by a new journal, the International Journal of Infrared and Millimetre Waves, which will include the proceedings of the Conference on Infrared and Millimeter Waves each year and by another proposed set of review volumes.

Both are edited by Button.

The present series is timely and will be a useful reference to those who work in this part of the electromagnetic spectrum. In view of the high Australian price, it is unfortunate that many will need to purchase more than one volume in the series to cover the different aspects of his or her field.


Reviewed by J.E. Cook, Environment and Public Health Unit, AAEC, Mascot, N.S.W.

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This little book consists of a collection of papers presented to a meeting of the Science and Industry Forum of the Australian Academy of Science, 6-7 October 1978. It presents a disparate set of views on risk attached to variously qualified and quantified accounts of the hazards associated with genetic engineering, conservation, the nuclear industry, pharmaceuticals, pesticides and the activities of the media, together with a foreword and an introduction.

Curiously, and disappointingly, it contains no account of any discussion following presentation of the papers at the meeting. Curious, because a foreword states "The Academy's Science and Industry Forum meets twice a year to discuss a topic of current concern to Australian society and of particular interest to the scientists, industrialists and public servants who are its members". Did the meeting generate no discussion at all amongst those attending? Disappointing, because post presentation discussions are often the most immediately enlightening and entertaining parts of published conference proceedings, being indicators of the originality or contentiousness of the material presented.

The reviewer suspects that the reaction of those attending to the material presented was much like his own on reading the book. The individual papers are informative, if sometimes baffling conceptually, while the introduction, in a short six pages, makes a commendable attempt to present the view that a reasoned discussion of risk requires risks to be quantified, but the whole is disappointing: it fails to stimulate.

In short, if you want a record of the material presented at this meeting, here it is. If, on the other hand, you want an introduction to risk, risk assessment and factors determining societal apprehension, keep watching the literature and the book reviews: the subject is very much in its infancy (the first journal devoted entirely to risk is being launched this year).


Reviewed by E.D. Fackerell, Department of Applied Mathematics, University of Sydney.

This volume contains the proceedings of the 1978 Cracow School on Cosmology which was devoted to discussions of physical processes playing an important role in the development and structure of the physical universe. The title may be a little misleading since the first quarter of the volume contains a detailed description of M.A.H. McCallum of the mathematics of homogeneous anisotropic cosmologies. It is interesting to note that McCallum states near the beginning of his article that 'the real resolution of the difficulties of cosmology may lie with the consideration of inhomogeneous models' (p.3). Dr. McCallum's article is of importance for more mathematically minded cosmologists.

The contributions by the other authors are more physical and do not involve difficult mathematics. Three of these contributions are devoted to aspects of the cosmic microwave background radiation. The aim of R.B. Partridge's article is to discuss the question 'What can observations of the cosmic microwave background tell us about the origin and structure of the Universe?'. Partridge gives a lucid
discussion of the role of the background radiation in galaxy formation in the framework of a sketch of the theory of density fluctuations. His point of view is that of an observationalist and the second half of his article discusses observational parameters, observational difficulties, required corrections and statistical analysis. His article concludes with a review and analysis of existing measurements and their bearing on the large scale isotropy of the universe, together with a list of possible new directions in observational work. Ya.B. Zel'dovich has a detailed article on the physics of the background radiation and its role in the formation of galaxies. G. De Zotti has a succinct article dealing with the very important question as to whether any evidence of a deviation from a black body spectrum of the background radiation can already be found. Other contributions deal with the creation of particles by a gravitational field (Zel'dovich), viscous dissipation and evolution of homogeneous cosmological models (N. Caderni) and a unified treatment of the different approaches to clustering of galaxies (G. Dautcourt).

The final contribution by M. Heller is a fascinating brief account of the cosmological work of Lemaître with special reference to the Lemaître archive at Louvain. Two of Lemaître's original (1927) drawings of all possible solutions of Friedmann's equations with constant positive curvature are reproduced here.


Reviewed by K.C.A. Crane, Division of Applied Sciences, CSIRO, Lindfield, N.S.W.

This book is a "rapid manuscript reproduction" of the papers presented at a symposium of the same name sponsored by the Materials Research Society. The symposium is the second of four that have been held each November since 1978 on the use of directed energy sources for materials processing. Proceedings of the first and third symposia have also been published.

Lasers and electron beams have the capability of localizing a heat-treatment process both spatially and temporally. Thus the near-surface region of a material may be subjected to extreme heating and cooling rates while the bulk of the material remains unaffected. The significance of this capability, particularly in the case of semiconductors, was not widely appreciated until the mid 1970s after pioneering work in Russia.

The book described here presents 106 papers in an attempt to summarize the major advances in the field, but only for the year prior to November 1979. Most of the papers discuss the use of beams for the annealing of displacement damage in ion-implanted semiconductors. Others are concerned with applications of beam processing to ohmic contact formation and fabrication of semiconductor devices. Only 11 papers are devoted to processing of ion-implanted metals and surface alloying of films deposited on metals.

The lay-out of the papers is of high quality. All figures and drawings are clear and well captioned, equations are neatly typed, and references are abundant. The editors claim that each paper was refereed, and the technical content is generally high.

However, in common with most publications arising from symposia, the scope of the book is quite limited. Besides the limitations already mentioned, others exist. Only about 24 papers are based on work performed outside the U.S.A., and none are by Russians. (One is by Australians.) In addition, a comprehensive introduction for non-specialists in the field is lacking, despite the inclusion of some review-style invited papers. Some of the papers are now outdated. For example, a nonthermal phenomenon was proposed in this book as being the dominant mechanism involved in the pulsed laser annealing of silicon, but this is not now generally accepted. In addition, this book is less critical than other recent work in relation to the cost effectiveness of lasers and electron beams compared with conventional heat sources for some applications. Nevertheless, a specialist in the field of beam processing of semiconductor materials would probably find more relevant in-depth information in this book and in those from the three related symposia than in any other source of comparable price.


This book is a collection of papers in the "Benchmark Papers in Acoustics" series. It will provide rewarding "browsing" for anyone with an interest in disc recording and reproduction, but most will see it as a "library" book rather than one for personal collections. The papers cover the period 1926-1971, with material describing early acoustic and electrical systems through to quadruphonic systems, and concentrate on the recording medium and cutting and playing transducers rather than full systems. Such a collection of papers is valuable in dispelling the idea that techniques in modern usage are all recent developments. The development is shown by a half dozen papers for each major topic.

**Getting IT together**

"Britain will have to get its act together" according to Mr Kenneth Baker, Minister for Information Technology, at the launch of Information Technology Year 1982. Mr Baker was speaking of Britain's comparative inactivity in this field, where research has shown that information technology is used by only 50% of firms. Without the necessary investment, the Minister thought that Britain's economic decline would 'pretty soon' be no longer relative, but absolute.

Mr Baker defined IT as 'everything from space satellites to space invaders'. More technically, it is the use of computers, microelectronics and telecommunications to help us produce, store, obtain and send information in the form of pictures, words or numbers, more reliably, quickly and economically. The government aims to encourage awareness of IT in both industry and commerce, and among the general public.

*Reprinted from Physics Bulletin*

The Australian Physicist, Vol. 19, June 1982 — Page 103
Improved Solar Collectors

The familiar flat plate solar collector used for heating domestic hot water is not effective above 60°C. Improvements to the glazing and the absorbing surface allow collectors to operate effectively up to 90-95°C. Such collectors are available in Australia and have been used on a number of CSIRO-sponsored demonstration installations.

To collect usable energy at temperatures up to 150°C has usually involved the use of evacuated tubular collectors or concentrating collectors. The manufacture of these is not compatible with the technology being used by much of the present industry. The present type of non-concentrating flat plate collector, but has been studying ways to extend the temperature range of flat plate collectors. Specifically they have been looking to reduce, by physical methods, the heat loss by convection between the absorber surface and the glass cover. This work, funded by National Energy Research, Development and Demonstration Council, has resulted in a patent application being made for a particular type of convection suppression device. This device is essentially a series of FEP Teflon slats below the glass cover. The performance of the collector depends upon the geometry and orientation of the slat within the collector, which are specified in the patent application.

The Division is planning to release the details of this work to industry in April and to enter into licence arrangements with interested companies.
— CSIRO Minerals and Energy Bulletin, April 1982

Five Radio Telescopes Join In Experiment

A 'cannibal' star, with the mass of our sun but probably only a few kilometres across, will be among more than 30 radio sources in the southern sky to be studied in an experiment for the first time linking five Australian radio telescopes to form a giant radio-telescope spanning half the continent.

The 'cannibal' star, Circinus X-1, is feeding off another star, a super-giant star of about 20 solar masses, from which it 'sucks' huge amounts of matter when it approaches in orbit every 16½ days.

The project is to be a neutron star, but some astronomers believe its ultimate fate may be to develop into a black hole — an even smaller body with a gravitational field so strong that not even light can escape from it.

At present, the gravitational field is so strong that it attracts matter from the larger star, accelerating it to very high speeds. When the matter crashes onto the surface of the small star, it gives off an intense burst of x-rays, visible light and radio waves.

The phenomenon is of great interest to astronomers because it provides a high speed model of the revolutionary processes at work in all stars. By recording changes in the radio emissions over only a few decades they will be able to study processes that would otherwise take millions of years.

The link-up of five Australian radio telescopes, at Sydney, Parkes, Tidbinbilla, Hobart and Alice Springs, will be the most ambitious application to date in the southern hemisphere of a technique known as Very Long Baseline Interferometry (VLBI), a relatively recent development which has produced some exciting results in the northern hemisphere.

'This is by far the most important application of VLBI in the southern hemisphere so far', he said. 'The use of more than two telescopes will result in a tremendous increase in the quality of the radio maps we can make.'

For the first time, we will be able to make detailed maps of radio sources such as Circinus X-1. The resolution of the telescope will be 5-10 milli arc seconds roughly comparable to being able to focus from Melbourne on a 1 cent coin in Sydney. 'Staf from the University's Department of Electrical Engineering and from the School of Physics will man the Fleurs radio telescope 20 hours a day throughout the experiment.

One of the most difficult parts of the experiment will be to synchronize all five telescopes to receive radio signals from the same object at the same moment. This will be achieved using atomic clocks, accurate within billions of a second, and high-speed videotape recorders. Much of the necessary extra equipment has been lent by the NASA Jet Propulsion Laboratory (JPL) in California, and two NASA scientists have assisted in the preparations and modifications to the Australian telescope over the past two years.

The experiment will also be used to test new geophysics mapping techniques capable of measuring distances of over 500 kilometres on earth to accuracies of between 5 and 10 centimetres. Scientists from the Department of Surveying at the University of New South Wales and from the National Mapping Authority will be involved.

Due to Australia's exceptional geophysical stability as a continent, it is one of the best places to demonstrate the effectiveness of the new technique, which will assist in the navigation of spacecraft and will contribute to knowledge about earth crustal movements and the motion of tectonic plates.

The experiment is a testing ground for the proposed $25 million Australia Telescope which is expected to link radio telescopes across the continent to form a powerful world-class instrument, by the end of this decade.

A member of the experimental team, Dr David Jauncey of the CSIRO's Division of Radiophysics in Canberra, said that Very Long Baseline Interferometry would not rule out the contribution made by individual radio telescopes.

'Experiments like this give us a better variety of detail to work from,' he said. 'The principle is the same as if you were studying a picture of a person: You need all the detail from the finest to the coarsest.'

Tom Gosling
University of Sydney News
25-Tonne Thermos Flask

A giant ‘thermos flask’ — so sophisticated it could keep coffee too hot to drink for five years at a stretch — is part of The Commonwealth Industrial Gases Limited’s contribution to developing the vast energy fields of Australia’s north-west shelf.

The 10 metre long insulated container brings liquid helium from the central USA to Western Australia. The helium is needed by divers working on the offshore rigs — for they work so deep that they cannot use nitrogen/oxygen mixtures in their breathing tanks (under the enormous pressures of water at that depth nitrogen is absorbed in the bloodstream, causing a condition known as “the bends” which can be fatal; helium does not). Helium is therefore vital to the project.

The major commercial source of helium is a few natural gas wells in the USA where it occurs in small but recoverable quantities. The helium from those wells is shipped to Australia to enable underwater engineering associated with offshore oil production.

A problem is that the only effective way to transport large quantities of helium is in liquid form. Keeping it cold enough to remain liquid throughout the six week journey is a real test of technology.

The filled container weighs just under 25 tonnes and contains 4,655 kg of liquid helium. The shipment will produce 26,000 cubic metres of helium gas. If the helium were delivered in gas in cylinders a 25 tonne shipment would contain only 3,000 cubic metres of helium gas.

Centralised Electron Microscope Unit has Important Training Role

The Electron Microscope (EM) Unit at the University of Sydney now in its 25th year, is unique in the services it provides to researchers and the courses it runs for staff, students and outsiders, says its Director, Dr David Cockayne.

Most other EM Units in Australia are for applied or research purposes and do not run training programs. Furthermore, Dr Cockayne believes no EM Unit anywhere in the world provides a comparable range of courses and equipment for students and staff.

While on nine month’s study leave which he has just begun, Dr Cockayne, a physicist, will look at the latest developments in courses run on electron microscopy by the Royal Microscopical Society. Concurrent with his study leave, Dr Cockayne is on the first Visiting Anglo-Australian Royal Society Fellowship. He will spend nine months at Oxford devoting most of his time to the study of high resolution microscopy. Dr Cockayne has been director of the University’s EM Unit since 1974.

The establishment of the EM Unit in January 1958 was very farsighted at the time, says Dr Cockayne. It was the first centralised EM facility to be set up in Australia. Under the direction of Dr D.J. (Gordon) Drummond, it began in one room, housing a single microscope — a Siemens instrument which only recently came to the end of its life.

Today the Unit has four transmission electron microscopes, three scanning electron microscopes, an electron probe and a range of major specimen preparation equipment and other items. This is the largest single collection of such equipment in Australia. Staff and students in all faculties may learn how to use these facilities, for approved research or teaching programs.

— University of Sydney News

Are Scientists Numerate?

In his Turner Lecture of 1938, Arthur Eddington followed the spirit of Lord Rayleigh, who implored scientists to express themselves in numbers. "... there are 15,747,724,136,275,002,577,605,653,961,181,555,468,044,717,914,527,116,709,366,231,425,076,185,631,031,296,408 protons in the universe and the same number of electrons," Eddington said.

Alas, precision has slipped, but the spirit of numbers lives on. The president of the Institute of Physics, Sir Denys Wilkinson has delivered an address to the Institute entitled "Physics the next 1,000,000,000 years." There will be no surprises for a while!

Opening of Science Education Centre

A new venture in science education was launched in Melbourne in April. It is CSIRO’s Science Education Centre at Hightett.

Aimed at secondary school students, the centre has been designed to fire the imagination of students with enthusiasm for science.

It has been established with the support of the Victorian Education Department which seconded a science teacher to CSIRO to set up and operate it.

During half day visits, students will be involved in activities which include experiments, manipulation of working models and interactive exhibits, as well as demonstrations and audio visual presentations.

On opening the Centre, the Minister for Science and Technology, Mr Thomson said that in the Australian scientific environment which is dominated by Government funding, CSIRO obviously has a major role to ensure as many people as possible benefit from its research work.

"This Education Centre, like many other community based projects supported by CSIRO, is an example of the effectiveness of that role," Mr Thomson said.

New Directory to Science and Technology in the Commonwealth Sector

The publication of this new Directory by the Department of Science and Technology represents a significant and practical contribution to the information needs of the scientific and technological community, Members of Parliament, officials and the interested members of the public. It is a comprehensive handbook to more than 200 Commonwealth agencies.

The Australian Physicist, Vol. 19, June 1982 — Page 105
The agencies are listed by Ministry, alphabetically, by discipline and by function. Charts show major channels of advice, flow of funding and interaction between agencies. The listings cover departments, boards, committees, councils, commissions, bureaux and panels with details of their structures, responsibilities and membership.

The result is a valuable complement to other publications, such as the Science and Technology Statement, which provide information on Commonwealth involvement in science and technology.

The Directory is seen as a significant step forward in the provision of information to the public, and will be of use both within the private and Government sectors.

The Directory will be available through Government and other bookshops and is expected to retail at about $6.00 a copy.

Portable Meter Measures High Voltage and Static Electricity

A portable instrument designed at the CSIRO Division of Applied Physics for measuring electric fields in the laboratory, factory or industrial works is available for commercial development.

It monitors DC and AC fields over the range of 20 to 2000 kV m⁻¹ with an accuracy of better than 1%.

The Division believes an electrostatic fieldmeter of this type may prove attractive to the electronics, plastic film and textile industries for monitoring accumulation of static charge. It could also find application in non-contact measurement of high voltages in power stations and substations. Another possibility would be to use it as a research tool for the study of electrostatic phenomena.

The instrument measures electric field directly. The potential difference (in volts) between an electrically charged surface and the instrument is easily calculated by multiplying the measured electric field by the distance (in metres) between the surface and the instrument.

The fieldmeter’s head unit contains a four-bladed rotor and segmented sensing plate driven by a small electric motor, as well as electronics to process the signals. A novel multi-bladed rotor system is the main feature distinguishing it from other fieldmeters. Use of such a rotor enables the meter to measure both DC and AC (up to 60 Hz) fields.

The prototype instrument also contains an electronic control unit consisting of a signal amplifier, phase-sensitive-detector, reference channel circuitry, power supply regulators and a digital panel meter. Additionally, an analogue output jack enables the fieldmeter to be plugged into data processing and recording equipment.

—CSIRO Industrial Research News

Fluidized-Bed Combustion of Coal Waste is Cost Effective

Australia’s coal is washed before being exported to world markets, leaving behind unsightly wastes which are a potentially valuable energy resource. In fact each year the energy value of these coal washery wastes equals that of all the brown coal used for electricity production in Victoria.

The Division of Fossil Fuels, in collaboration with the Joint Coal Board, has successfully operated a 2 tonne/hour pilot plant at the Glenlee coal washery of Clutha Developments Pty Ltd for the disposal of coal wastes by fluidized-bed combustion.

An independent examination of the full-scale commercial feasibility of the process has been carried out by Merz & McEldon & Partners, consulting engineers. This study found that the fluidized-bed combustor provides an economically sound and environmentally attractive means of coal waste disposal. Substantial cost savings to the coal industry would result from the use of these combustors, which allow better waste management coupled with improved energy recovery from mined coal. The new technique looks particularly promising in the light of the expected large increases in coal exports.

Contact: Dr Robert Labauze, Division of Fossil Fuels, P.O. Box 136, North Ryde, N.S.W. 2113. Tel: (02) 887 8666.

New Work on Accelerator Expands its Existing Research Functions

The ANU’s I4UD Pelletron has been significantly upgraded, adding an extremely powerful research technique to its existing capacity.

The accelerator, in the Department of Nuclear Physics, Research School of Physical Science, now has an experimental technique shared by only three or four other accelerators in the world.

The technique allows studies of nuclear states which decay so quickly that up till now they could not be observed directly.

The upgrading of the accelerator was partly funded by a $90,000 grant from the University’s Major Equipment Committee last year. Work on the first stage was completed about three months ago and was followed by a successful test program.

Dr Trevor Ophel, Professorial Fellow in the Department, said that the accelerator normally produced a steady flux of beam particles.

“What we are doing now is to compress the beam to a point to form high-intensity bunches about one nanosecond wide,” he said.

This pulsed beam allows study of nuclear phenomena which occur within fractions of a nanosecond and are observable only in the periods between beam pulsos.

As well, improved methods of heavy ion identification can be exploited from direct measurement of ion velocity over short distances.

This makes it possible to do a great deal of work that just cannot be done otherwise. He said the pulses are produced by a number of elements outside the accelerator. At the low energy end at the top of the accelerator the beam particles move relatively slowly and it is here that the compression or bunching of the particles takes place.

The bunching is done by applying a very high frequency voltage wave form. The shape of the wave is a sawtooth and creates the particle compression pattern needed. About 50 to 75 per cent of the particles are bunched together, the rest are distributed between the bunches as background dark current.
After the beam particles are accelerated through the Pelletron a high frequency chopper assembly separates the bunches from the background. The bunches pass out of the accelerator into the beam transport system, and the unwanted direct current or background is deflected.

Dr Ophel said that the recent testing showed efficient operation of the low energy buncher. More than half the beam particles were easily compressed into one nanosecond-wide bunches and subsequent chopper operation eliminated the intermediate direct current.

The next stage will see the compression increased by a factor of 10 by using a superconducting resonator, that is, a resonator at liquid helium temperature.

The resonator has already been built by Applied Superconductivity, of Pasadena, California, and is due to be delivered later this month. The other equipment, including the low energy bunchers and the chopper were designed and built in the Department of Nuclear Physics under the supervision of Dr D.C. Weiss, with assistance from the Argonne National Laboratory and the Florida State University.

Dr Ophel said that completion of the first stage already represented an addition of an extremely powerful research technique. Many new types of measurements will be pursued against even more elegant studies which will be possible when the superconducting resonator is installed,” he said.

The Pelletron has been operating on campus since 1974 and till recently was the highest voltage machine in the world.

ANU Reporter

Spark Source Mass Spectrometer for Trace Element Studies

With the formation of the new CSIRO Division of Energy Chemistry, a spark source mass spectrometer is now available for multi-element trace analysis of a range of energy-related materials, including Australian oil shales and coals. This will aid the Division's research into the trace element distribution between products and residues in the processing of oil shales and the pyrolysis and liquefaction of coals.

The instrument, a JEOL JMS-01-BM2 mass spectrometer, is capable of analysing up to 70 elements simultaneously with sensitivities in the range 0.01 to 0.1 µg per gauss. This is accomplished by recording the mass spectrum of a sample, produced by a spark ion source, on a photographic plate. In addition, selected nuclei can be measured directly by using a computer-controlled detection system developed within the Division. This system has been found to be very useful for measuring rare earth concentrations in rock.

Noise Attenuation

Noise in duct systems can be a major industrial, social and environmental problem. Engine exhaust pipes, air conditioning and ventilation ducts and power station stacks are familiar examples of where gases and noise are being moved from place to place. Although adequate methods are available for eliminating high frequency noise, the low frequency components are difficult and expensive to eliminate. In addition, the elimination of low frequency noise often imposes major increases in energy use because more pressure is required to move the gas through the silencer. This often results in a larger fan and motor being required.

Recent advances in electronics have enabled new methods of attenuation to be considered which do not restrict the flow, do not increase energy use and are particularly suitable for low frequencies. The CSIRO Division of Energy Technology is investigating a method called active attenuation. This entails measuring the signature of the noise at one point in the duct and then introducing a secondary sound of the opposite signature. This 'anti-noise' signal attenuates the original, unwanted noise.

Experimental work at the Division has commenced with periodic, random and transient noise sources being studied. It is hoped to achieve a reduction of up to 15 dB (subjectively 50% - 75%) with a broadband noise of 30-700 Hz. The next stage will be to introduce flow into the duct. Turbulent pressure fluctuations in the flow will make noise attenuation more difficult to achieve.

— CSIRO Minerals and Energy Bulletin

Coal Cleaning by Flotation

The previous issue of the Bulletin described the start of a joint project between the Divisions of Fossil Fuels and Mineral Chemistry to study some of the fundamental principles of coal flotation in relation to selected practical problems. This project has substantial support from National Energy Research Development and Demonstration Council funds.

Flotation tests carried out at the Division of Mineral Chemistry on a lower-rank black coal from the Great Northern seam, Newcastle district, showed that it was difficult to reduce the original ash yield of ~18% to less than ~12% and maintain high recovery of coal. The ash yield of the flotation concentrate was found to be mainly the result of the recovery of composite coaly grains containing both carbonaceous matter and mineral matter. Even 50% recovery of grains were composite in nature, the mineral matter being very finely disseminated.

Five factors were found to affect the floatability of such composite grains: rank, type, grade, particle size and degree of oxidation. These factors interact, in a way which is not yet properly understood, to determine the floatability of a given grain.

However, for a coal sample of given rank the floatability of coaly grains of a given size was found to decrease with increasing relative density of the grains. For Great Northern coal in the size fraction 250 + 149 µm, the recovery decreased from 46 to 20% as the relative density of the grains increased from 1.28 to 1.63. The fall in flotation recovery correlated with an increase in the proportion of hydrophilic mineral matter in the composite grains, rather than with the changing proportions of the macerals vitrinite and inertinite. Work is in progress to see whether this strong dependence of floatability on relative density occurs in other coals of different rank, type and grade.

Contact: Dr Len Warren, Division of Mineral Chemistry, P.O. Box 124, Port Melbourne, Vic. 3207. Tel: (03) 647 0211.

The Australian Physicist, Vol. 19, June 1982 — Page 107
Defence Science Develops Laser Target Designator

The crews of RAAF strike and ground attack aircraft will benefit considerably from the successful completion by the Defence Science and Technology Organisation of a project which has developed Australia’s own laser target designator system (LTD) for training purposes. LTD enables a 900 kg bomb, launched up to 10 kilometers away, to be guided within 10 meters of its target.

The instrument beams laser light at a selected target which must be in line-of-sight and can be as far as 10 km away. The operator maintains radio contact with the aircraft and illuminates the target with laser light for a short time before the projectile is due to hit. A sensor in the projectile’s nose responds to the laser light scattered from the target and homes the weapon onto the target.

The only precision laser guided munition at present in use in Australia is the Texas Instruments (USA) Paveway Laser Guided Bomb. Army is now procuring 155mm guns capable of firing the Martin Marietta Cannon Launched Guided Projectile (CLGP), called Copperhead. Guided by a suitably positioned forward observer equipped with an LTD, Copperhead is capable of hitting a moving tank more than 20 km from the artillery battery.

LTD systems are capable of airborne use especially if combined with a TV or infra-red target detection system and stabilised optics. Experimental equipment of this type is being developed and a specification is being prepared for a pod-mounted system to provide the RAAF with an airborne LTD system for training use.

The knowledge gained in developing and using these systems enables the Australian Defence Department to be better informed on modern high technology weapon systems and to better assess the merits of any overseas systems offered to the Defence Force.

Concurrent with these developments, DSTO is actively engaged on a program to support the development of laser systems technology in Australian industry, thus providing an in-country capability to design, manufacture and service military equipment.

— Defence News Release

First Commercial Gratings Made by Holographic Technique in Australia

Production of diffraction gratings, is now well and truly in the high technology arena.

In the holographic process for making diffraction gratings, thousands of precisely parallel and equally spaced grooves per millimetre are etched by a photo-laser technique onto the front surface of the grating. This process is being used in a joint project of the CSIRO Division of Chemical Physics and Varian Techtron Pty Ltd.

The latest microcomputer-controlled UV-visible spectrophotometers produced by Varian Techtron contain these gratings — known as holographic gratings. The company is manufacturing them under licence to CSIRO.

The gratings, which have a quasitriangular groove profile (the triangle has rounded corners), have been developed in the Division of Chemical Physics and have remarkably fine tolerances. The grooves are parallel and equally spaced to within 1/200th of the wavelength of light, and that is approaching molecular dimensions.

In performance tests at the Varian Techtron laboratories, CSIRO/Varian Techtron gratings were more than twice as good in terms of signal-to-noise ratio as the many European holographic gratings tested.

Ideally, if all the grooves are perfectly equally
spaced and parallel, then all the light of a given wavelength will be diffracted at one angle. Thus there will be no stray light and, because of the very high signal-to-noise ratio, the analytical instrument will be well equipped to discern very weak signals in the presence of strong ones nearby.

A major advantage of the holographic technique over the older ruling-engine method for producing gratings is that all the grooves are recorded simultaneously in a matter of minutes, instead of sequentially over 10 or more days. Furthermore, since the groove spacing is determined precisely by the wavelength of the laser light used to make the grating, there are no errors in groove placement.

With a ruled grating, there is always a slight irregularity in the spacing of the grooves owing to non-uniform movement of the engine's reciprocating mechanism and to temperature changes over the long ruling period.

Another point in favour of the holographic technique is that capital investment in equipment is considerably less, although the process is extraordinarily sensitive to contamination, whether by handling or by traces of airborne dust, and rigorous precautions, reminiscent of those necessary in the integrated-circuit microchip industry, must be taken.

The new gratings produce five times less stray light than the best ruled ones. This is important both in UV-visible spectrophotometry and in emission analysis for trace elements, where the analyst may be looking for heavy metals at the part-per-billion level in the presence of high concentrations of other materials.

A feature of the holographic technique is that a sinusoidal groove profile, not possible with ruled gratings, can also be produced. Gratings of this type are used, for instance, in tuning devices for dye lasers.

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New Quasar Discovered

A team of Australian and British astronomers has discovered a quasar at the edge of the Universe. The quasar is the most distant object yet discovered.

The quasar has been found by Dr Bruce Peterson (Mount Stromlo and Siding Spring Observatories), Dr Ann Savage (U.K. Schmidt Telescope of the Royal Observatory, Edinburgh) and Dr David Jaucey and Dr Alan Wright (CSIRO Division of Radiophysics).

This important discovery, at the very fringe of the known Universe, culminates an intensive, six-year search, using radio and optical telescopes in Australia.

The discovery has created an enormous excitement among astronomers, opening up a new debate on the extent and age of the Universe, and rekindling the controversy about the nature of quasars.

Quasars are the most distant and most luminous bodies known, producing enormous energy from a comparitively small source. More than 200 have now been discovered, but the source of their intense radiation remains unknown.

The newest quasar, code-named PKS 2000-330, was calculated to be emitting the energy of 100 million million suns, making it the most luminous known object in the universe. It is moving away from the earth at close to the speed of light making it 20,000 million light years away, and the light now being detected would have left the quasar long before the formation of the earth.

PKS 2000-330, was discovered using CSIRO's 64-metre radiotelescope at Parkes. An accurate radio position was measured using the Tidbinbilla radio interferometer of the Deep Space Network near Canberra, while the U.K. Schmidt telescope at Siding Spring Mountain near Coonabarabran was used to identify the optical object. Finally, the optical spectrum obtained on the Anglo-Australian telescope also at Siding Spring, proved conclusively that this quasar was further away than any other known object within the Universe.

On announcing the discovery of the new quasar, Mr David Thomson, the Minister for Science and Technology said that the team work associated with this significant discovery, highlights the necessity for close co-operation within the astronomical community in Australia.

French Government Scientific and Professional Scholarships, 1983

The French Government is offering a limited number of scholarships to enable Australians working in scientific and professional fields to visit France to further their experience through consultation with colleagues or contacts in France, and, where appropriate, participating in their programs.

Priority will be given to scientific research, particularly in the fields of oceanography, geology, medicine and alternative forms of energy (e.g. solar, wind, tidal power). However, these scholarships may also be awarded in such diverse fields as mass media, economics, town planning, architecture, public administration and education.

The scholarships are normally tenable for between three and six months. This series of awards covers the period 1 January to 31 December 1983. However, the French summer vacation period of July-August should be avoided wherever possible.

Successful applicants will be required to submit monthly progress reports on their studies and a final report at the conclusion of their course. The scholarships do not cover postgraduate study.

Application forms may be obtained from and should be returned to:

The Secretary, Department of Education (French Government Scientific and Professional Scholarships), P.O. Box 826, WODEN, A.C.T. 2606.

The closing date for the receipt of applications is 28 May 1982.

SYLLABUS FOR DETECTIVE STORY AS WRITTEN BY A PHYSICS PROFESSOR

CHAPTER I Origins of Law in Babylon
II Constitution of United States
III Basic Organisation of Police Department
IV Elements of Courtroom Practise
V Theory of Fingerprints
XXX (Last page) The Corpse

SALES: Zero

(Solution left to the Student)

(from Physics Today, November 1981)
Conferences and Meetings

1982
June 4-6  5th National Conference of the Audiological Society of Australia, Leura.
    Ms L. Goodall, National Acoustic Laboratories Training Centre 71-73 Arches St., Chatswood, N.S.W. 2067.
August 24-25 Workshop on the Bicentennial History of Science, Canberra.
    Mr P. Vallee, Australian Academy of Science, P.O. Box 783, Canberra City, A.C.T. 2601.
August 30-
Sept. 3  2nd IUPAP Semiconductor Symposium. Surfaces and Interfaces: Physics and Electronics.
    Trieste, Italy.
Sept. 1-4 3rd International Conference on Vibrations at Surfaces.
    Asilomar, California.
October 25-28 Xth International Symposium on Discharge and Electrical Insulation in Vacuums, Columbia,
    South Carolina.
Nov 26-
December 3 7th International conference on Vacuum Metallurgy, Tokyo, Japan.

SOLAR WORLD CONGRESS

CALL FOR PAPERS
Prospective contributors are invited to submit a brief (300-400 word) abstract of their proposed paper. This
should reach the Technical Programme Committee by August 16, 1982.

SUBJECT GROUPS

1 Thermal applications: buildings
   a — passive heating
   b — passive cooling (including earth-coupled buildings)
   c — active heating of space and domestic hot water,
   d — swimming pools and heat pump applications
   e — active cooling: refrigeration, cold storage
   f — active cooling: open cycle systems
   g — other

2 Thermal applications: industry
   a — low temperature (≤ 120°C) process heating
   b — high temperature heat production
   c — drying: crops, timber, minerals, etc.
   d — agricultural applications (including greenhouses, fish ponds)
   e — desalination and distillation
   f — irrigation and water pumping
   g — other

3 Electricity and mechanical work
   a — photovoltaic and photogalvanic systems
   b — low temperature mechanical-electrical systems
      (including OTEC)
   c — high temperature STEPS (solar-thermal electrical power systems): power towers
   d — STEPS; other concentrating systems
   e — solar ponds
   f — thermal and electrical storage systems
   g — other

4 Materials and chemical and biological systems
   a — selective surfaces
   b — materials used in solar energy systems
   c — photo- and thermo-chemical processes and systems
   d — photobiology and plant mass production
   e — plant-to-liquid conversion to fuel
   f — novel systems and processes not included elsewhere
   g — other

5 Resources and wind energy systems
   a — radiation and meteorological data, measurement, instrumentation
   b — data processing, presentation, modelling
   c — wind energy systems (to be conducted in conjunction with the Australasian Wind Energy Association)
   d — other

6 Non-technical issues
   a — economic and policy issues
   b — planning, environmental, legal and regulatory issues
   c — standards and testing
   d — other
   UNESCO SESSION:
   e — international programmes
   f — special problems of developing countries

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