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FRONT COVER
Insert (left hand bottom corner): NASA's Airborne Infrared Observatory, a Lockheed C-141 Starlifter four-engine jet transport fitted with a 91.5cm infrared telescope which is inside open port high on the fuselage just in front of the wing. Control panel for the telescope is at right. Telescope installation is forward, behind the pressure bulkhead at left of picture. (Pictures courtesy of NASA)

The Australian Physicist, Vol. 24, 1987-Page 101
The statements made and the opinions expressed in the Australian Physicist do not necessarily reflect the views of the Australian Institute of Physics, its Council or Committee.
Editorial

In April of last year I devoted an editorial to the growing strength of physics in various Asian countries lying to the north of us. You may wish to refer to that issue of TAP, because the subject is now back in our court for urgent further discussion.

In the last month's issue, page 97, we published two very important invitations. The first came from three physicists, C.N. Yang, Y.W. Chan, and K. Young, The University of Hong Kong. The other three came from the Physical Society of Japan and was forwarded to us by their Executive Secretary, Akira Miyake. In it the Physical Society of Japan extended a welcome to members of the A.I.P. to attend and contribute to their 1987 Meeting. This invitation will, no doubt, be of great value to many of our members, and I hope that we have returned the invitation to the Japanese Physical Society to attend our Bicentenary Congress in January 1988.

The invitation from Hong Kong raised an issue of far reaching implication, namely the formation of a Federation of Asian Physical Societies. This issue is to be discussed at the Third Asia Pacific Physics Conference in June 1988. We must, therefore, start to discuss it immediately.

Firstly I would like to suggest that members of the A.I.P. use this Journal to discuss the various questions that may arise. These could range from the name of the Federation, to those eligible to join. What issues will the new Federation be addressing? To my mind spring the importance of joint research facilities, the teaching of physics and of ways to break down the language and cultural barriers that divide us. A Federation will demand a great deal of tolerance and good will from its members, political tolerance, religious tolerance and the acceptance of different living standards and customs. This can, of course be very enjoyable and often amusing. In my opinion the U.S.S.R. should be included in the Asia Pacific region as their vast scientific experience would enrich the Federation. But these issues are all open for discussion and should liven up The Australian Physicist until the December issue.

Secondly I would like the Executive to consider a referendum on the subject. This could easily be done by enclosing the voting papers with the annual subscription notices asking members whether or not to join. The results of the referendum would be available in time for the Bicentenary Congress in January 1988, where a session should be made available for discussion. The congress could then appoint a number of delegates to the Third Asia Pacific Conference with instructions from the A.I.P.

No doubt various physicists will immediately ask the question, who is going to finance the Federation thereby hoping to dampen all enthusiasm and stop all forward motion? To counteract this usual kind of sabotage, I am writing to the editor of "europhysics news" requesting him to tell us how the European Physical Society is being financed. I hope to be able to publish the reply in due course.

The Asia Pacific region also has a regional journal, the ASPAP News, whose first issue of 1987 arrived last month. It contains 48 pages of most interesting physics information and at $US1.00 represents a bargain. Copies can be purchased from Prof. C S. Lim, Department of Physics, University Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia. Prof Lim must be congratulated on putting together so many informative physics articles: The Quantum Hall Effect, Group Theory and Microcomputers, Coherent Emission Processes by "Our man McRae", two very interesting articles on Space Physics and Optical Astrometry in India, the Japanese outstanding TRISTAN Project and Synchrotron Radiation at Trieste. These articles are followed by information on physics education in the region, prizes received, book reviews, an amazingly long list of physics journals published in this region and conference announcements. From these it appears that the next ASPEN Physics Education Conference will be in Kuala Lumpur in October (14-17). The journal is well produced, and I do hope that physics departments throughout Australia will subscribe to it, as it truly contains a wealth of information.

Another related project, that I should mention here, is the ICTP (International Centre for Theoretical Physics) Donation Scheme. It endeavours to supply scientific journals and equipment to countries in need. The scheme was initiated by that great internationalist and physicist Abdus Salam. Those interested in helping should notify:

H.R. Dalafi,
International Centre for Theoretical Physics,
P.O. Box 586,
I-34100 Trieste, Italy.

There is certainly a great deal of useful equipment lying around in hospitals, that we may be able to donate.

Trudi Thompson.
What's NASA doing with a little Aussie logger?

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1987 Pawsey Medallist, Dr John Storey

Each year the Academy awards the Pawsey Medal to a young scientist for distinguished research in experimental physics. The medal commemorates the contributions of one of Australia’s leaders of radioastronomy, Dr J.L. Pawsey FAA, FRS. Many medallists have gone on to make further outstanding contributions to science.

Dr Storey, 35, has developed innovative instruments and applied them to important problems in astronomy and physics. The instruments may also have valuable industrial and medical applications.

He has devised means to detect biologically significant molecules in outer space and has also promoted far-infrared astronomy in Australia. The far-infrared spectrum is particularly useful for studying the shocks that accompany the formation of stars.

He is presently working on an original infrared detector for use on the Anglo-Australian Telescope at Siding Spring near Coonabarabran, NSW. BHP has shown interest in using the detector to find and efficiently extract valuable minerals.

Dr John Storey has proved brilliantly that he is thoroughly worthy of the Pawsey Medal, continuing the tradition of outstanding and innovative experimentalists who have made major contributions to the internationally recognized achievements of astronomical research in Australia.

The Medal

The Pawsey Medal commemorates the unique contribution of Dr Joseph Lade Pawsey (1908 - 1962) to science in Australia. Dr Pawsey was a radio physicist born at Ararat in Victoria and educated at Melbourne and Cambridge universities. In the 1930s he worked in London as a research physicist in television. He joined the CSIRO Division of Radio Physics in 1939 and in 1962 went to West Virginia as director of the US National Radio Astronomy Observatory. He was a fellow of the Royal Society and in 1954 became a Foundation Fellow of the Australian Academy of Science.

The Australian Academy of Science awards the Pawsey Medal to a scientist not over 36 years of age who has done distinguished research in experimental physics. The research should have been carried out mainly in Australia. There is no financial prize attached to the medal.

Many Pawsey medallists have gone on to make outstanding achievements in their field. Previous winners include the director of the CSIRO Office for Space Science and Applications, Dr Ken McCracken, who won in 1969, the Foundation Professor and Head of the Department of Applied Mathematics, Research School of Physical Sciences, Australian National University, Professor Barry Ninham (1971), the Professor of Theoretical Physics at the University of Melbourne, Professor Bruce McKellar, and other leaders of research in lasers, astronomy, surface forces and theoretical physics.

Dr Storey’s collaborator in the development of an Infrared array detector, Professor Martin Green of the School of Electrical Engineering at the University of NSW, is a leading solar cell researcher who won the Pawsey Medal in 1981.

The Winner

Dr Storey was born in Melbourne in 1951. His PhD work at Monash University took him into the field of biologically significant molecules in space. Dr Storey made a novel spectrometer capable of rapidly analysing the spectral fingerprints of molecules such as the amino acid, glycine. Such a molecule could support theories that life evolved in outer space. Unfortunately for the advocates of these theories, intensive searches of interstellar dust clouds have so far failed to find the amino acid spectra.

In 1976 Dr Storey moved to the University of California in Berkeley for postdoctoral research. There he worked on the design and development of infrared telescopes and spectrometers.

In 1981 he joined the astronomical staff of the Anglo-Australian Observatory in Sydney. In 1982 he began lecturing in the School of Physics at the University of NSW. He is now a senior lecturer. Dr Storey is an author of 68 published papers and is a member of many space research committees.

The Research

Dr Storey’s innovative work on astronomical instruments has also opened new areas for exploration. His particular interest has been the forgotten part of the electromagnetic spectrum, the far-infrared. Because of problems detecting infrared radiation, especially through the Earth’s infrared-absorbing atmosphere, astronomers have tended to ignore this part of the spectrum. Using detectors and aircraft that became available in the 1960s and 1970s Dr Storey has helped to pluck infrared astronomy out of the too-hard basket. The detectors came largely from military technology. The aircraft was a large Lockheed Starlifter, which NASA fitted out as the Kuiper Airborne Observatory in the late 1970s.

Dr Storey helped arrange for the aeroplane to visit Australia in 1983 and from an altitude of 12.5 km opened up the heavens in a way unobservable from the ground. The plane was above 99% of the atmosphere water vapour that absorbs most of the far-infrared radiation. His instruments first recorded molecules of carbon monoxide, ammonia and hydroxyl, which have been used to explore the interstellar shocks which occur with star formation.

At the University of NSW, Dr Storey, in collaboration with Professor Green, is making a detector for short-wavelength infrared radiation. The only other similar technology is being made by US defence contractors and is not available for civilian use.

The essence of the detector is a silicon chip with a thin metal film on the surface. Calcium fluoride or sapphire lenses focus the infrared radiation onto the surface and charge-coupled devices read off the number of incident photons. An image is then produced on a television screen.

The team lead by Dr Storey and Professor Green have put an array of 2048 detectors on a chip six millimetres square and plan to manufacture a detector with over 30,000 elements by the end of 1987. The array detector, supported by the Anglo-Australian Observatory, is principally for astronomical use.

But Dr Storey envisages many other applications. An infrared detector on an aeroplane or satellite could be used for remote-sensing, especially of minerals. Industrial processes which require remote temperature control, such as paper and steel-making, could use the detector. In medicine, thermography - the detection of hot and cold parts of the body - can reveal tumours and circulatory problems. Of course the military is interested in applications to surveillance and heat-seeking missiles.

BHP is already investigating the detector’s value for sensing minerals from the air and in the mine. Other companies have made inquiries.

Dr Storey believes that if a few problems are solved, and the US military continues to restrict its technology, Australian innovation could have a large lead on the rest of the world.

*The Australian Physicist, Vol. 24, 1987-Page 105*
Molecular Line Astronomy in the Far-Infrared
J.W.V. Storey, University of N.S.W.

Until 1968, it was generally believed that the interstellar medium was too harsh an environment for complex molecules to exist in. The discovery that year of interstellar ammonia and water vapour by radioastronomers at Berkeley showed that such molecules not only exist, but do so in abundance. "Molecular clouds", as they are now known, are vast regions containing up to ten million solar masses of molecular material, mixed with sufficient dust to shield the molecules from the destructive UV radiation of nearby hot stars.

Within a few years, molecular line radioastronomy was a thriving science. Although centimetre-wave telescopes, such as that at Parkes, continue to make important contributions, the field belongs mainly to the mm-wave astronomer. Particularly important is the J = 1 → 0 transition of carbon monoxide at 2.6 mm. This is a beautiful probe of the interstellar medium, tracing out the spiral arms of our galaxy just as the 21 cm HI line had done two decades previously.

Meanwhile, in the far-infrared, the technology of detectors, spectrometers and telescopes was starting to catch up. This part of the spectrum had lagged well behind the development of the optical, radio, and near-infrared, partly because no-one in military or commercial circles was terribly interested in struggling against the atmospheric absorption. Thus, not only was the far-infrared astronomer condemned to make observations from high altitude to get above the water vapour absorption, but a good deal of development was required of detectors, spectrometers and related instruments. Pioneering work in the 1960's by Frank Low and others demonstrated the potential for far-infrared astronomy from high-flying aircraft.

This provided the necessary stimulus for the instrument development needed to make far-infrared astronomy practical.

In 1975, flying on NASA's Learjet observatory with its 30 cm telescope, a group from Cornell led by Martin Harwit made the first far-infrared detection of an interstellar line; that of [O III] at 88 microns. The instrument they used was a simple, but highly effective grating spectrometer cooled to liquid helium temperature. Over the next few years this instrument explored the far-IR region, detecting the second [O III] line at 51 microns, plus the forbidden fine structure lines of [O I] and [C II].

At Berkeley, in the group led by Charles Townes, a different technology was being pursued, and a new, high resolution spectrometer was under development (Figure 1). This instrument used two metal-mesh Fabry-Perot filters: one a fixed, order-sorting filter cooled to liquid helium temperature, the other a tunable, room-temperature filter operating at up to 100th order. For far-infrared spectral line work, high resolution is of paramount importance. First, it confers the ability to discriminate against the forest of atmospheric lines that remain even at high altitude. Similarly, it reduces the continuum to the point where instrumentally-induced bumps and dips no longer cause confusion. Finally, it reduces the background radiation on the detector, decreasing shot noise.

At about the same time that the developments at Berkeley were occurring, NASA's new Kuiper Airborne Observatory was becoming operational. Installed in a C-141 four-engined jet transport aircraft, this 90 cm telescope peers through an open port in the side of the fuselage. Flights last up to 8 hours, with an altitude of 41,000 feet being used routinely and 45,000 feet obtainable for shorter periods.

In 1980, the Berkeley instrument flying on the KAO made the first detection of carbon monoxide in the far-infrared, picking up the J = 21 → 20 line at 124.2 microns, and the J = 22 → 21 line at 118.6 microns. Not surprisingly, the lines were detected first in the Orion molecular cloud, for years the favourite object of molecular line radioastronomers.

Radioastronomers have shown that a typical molecular cloud is cool, 10 to 30K, and so the chance of detecting such highly excited molecules may at first sight appear to be remote. However, observations of molecular hydrogen lines at 2 microns showed in as early as 1977 that at least some parts of some molecular clouds are in a very high state of excitation. This is believed to be due to the passage of hydrodynamic shocks, generated by the initial outbursts of the newly-forming stars.

Observations of molecular hydrogen, however, tell us little about the physical conditions in the gas, save that it is very hot. This is why the far-infrared lines are so useful. Over the next few years, many more lines of CO were observed, both at higher and lower quantum numbers. Figure 2 summarises these results, and shows a possible model fit to the data.

In 1983, agreement was reached between NASA and the then Department of Science to bring the Kuiper Airborne Observatory to Australia for a six-week observing program. For the first time, Australian astronomers were accorded Principal Investigator status, giving them four entire flights.

Figure 1. The Berkeley tandem Fabry-Perot spectrometer. This instrument has made the first detections of all the molecular species found so far in the 50 to 200 micron wavelength range.

Figure 2. Observed carbon monoxide line intensities, together with a two-component model fit. The curve marked LTE shows the intensities that would be observed if the gas was in thermal equilibrium at a temperature of 750K.
PAWSEY MEDAL

(The KAO had made one previous visit, in 1977. On that occasion Australian astronomers were also able to participate, but only as guest observers. It was during this 1977 expedition that observations of a Uranus occultation resulted in the discovery of rings about that planet.)

Based at Richmond Airforce Base (near Sydney) from May to June 1983, the KAO made many flights exploring the unique objects of the Southern sky. Even objects such as the Galactic Centre (which can be observed from Hawaii-based flights) are better studied from Australia because of the reduced zenith angle. Of particular interest was the detection during these flights of shocked CO emission from two new sources; the molecular ring around Sgr A and the H II region G333.6-0.2. Now Orion was no longer the only molecular cloud of interest to far-infrared astronomers.

Unfortunately, it now appears unlikely that that the KAO will ever return to Australia. A planned expedition in 1986 to observe, among other things, comet Halley, was called off at the last moment when it was realised that Australia would no longer provide a runway. That expedition was transferred instead to Christchurch, where operation from the International Airport was straightforward. At the time of writing a second, highly successful expedition to Christchurch has just been concluded. On this occasion comet Wilson was the main target, but supernova SN1987a also came under scrutiny.

In recent years, several other molecular species have also been detected in the far-infrared, notably OH, CH, and NH₃. Figure 3 shows an observation of Orion in which two molecular lines are present. The way to the future, however, is being pointed by the recent detection of HCl by Tom Phillips' Caltech group. In this case the technique used was not the "filter and detect" method of the optical astronomer, but heterodyne technology more familiar to radioastronomers.

Over the next few years, the battle for possession of the high ground at the peak of the room-temperature Planck function will be fought. Optical astronomers are storms up the steep side with their gratings, Fourier transform spectrometers and Fabry-Perots, while radioastronomers climb the Rayleigh-Jeans slope with their heterodyne techniques. In all probability both technologies will carve out their own niches but, since both sides are at present well away from the fundamental limits in sensitivity, tremendous opportunities exist for important discoveries to be made in this vast piece of spectrum.

ANNOUNCEMENTS

Heinemann Prize

The Head of the Department of Theoretical Physics in the Research School of Physical Sciences, ANU, Professor Rodney Baxter, has been awarded the 1987 Davie Heinemann Prize for Mathematical Physics. The award is administered jointly by the American Physical Society and the American Institute of Physics; it is given for distinguished work in mathematical physics. The citation reads: 'For his novel use of mathematical analysis to solve in exact analytical form problems of fundamental importance in statistical mechanics relating directly to co-operative phenomena, phase transitions and quantum field theory'.

The prize was presented in New York in March.

Emeritus Professor

The University Senate of UWA has conferred the title of Emeritus Professor on the former Deputy Vice-Chancellor, Professor Alan Boyle, in appreciation of his services to the University. Professor Boyle retired in February after nearly 24 years on the staff.

Personal Chair of ANU

A mathematics graduate of the University of W.A., Professor Kenneth Freeman has been appointed to a personal chair in the Department of Astronomy at the Australian National University. He was formerly Professorial Fellow at Mount Stromlo and Siding Spring Observatories. As both an observational astronomer and a theoretical astrophysicist, Professor Freeman is noted for his wide-ranging studies of the dynamics of star systems, especially barred spiral galaxies, elliptical galaxies and globular star clusters.

New Name for School

The Council of Macquarie University approved the renaming of the School of Mathematics and Physics to the School of Mathematics, Physics, Computing and Electronics, with Professor van der Poorten, Head of the School.

The Harkness Fellowships

For study and travel in the United States

Arrangements for the 1988 AWARDS from Australia

The closing date for applications is 31st August 1987. Application forms will not be made available after 17th August 1987. Application forms from the Honorary Australian Representative, Mr J. T Larkin, First Assistant Secretary, Department of Trade, Canberra, ACT, 2600.

The Australian Physicist, Vol. 24, 1987-Page 107
RARE EARTH

Report of Meeting 'Rare Earth Horizons 1987'

On 27 and 28 April the Department of Science and the CSIRO Division of Applied Physics held an industry research seminar at the National Measurement Laboratory, Lindfield NSW on rare-earth technology. The meeting followed two successful seminars in 1986 on 'Supermagnets' and 'Glassy metals' and had a similar aim: to establish a current Australian perspective on the history, science, technology and economics of rare earths, focussing on research and industrial developments flowing from that research.

The seminar was attended by over 150 people, of whom approximately 40% were from industry and commerce, 15% from CSIRO, 20% from tertiary institutions and 25% from Commonwealth and state departments and instrumentalities.

The newly-appointed Chairman of CSIRO, the Hon Neville Wran QC, opened the meeting and took the opportunity to make public the conclusions of the CSIRO/McKinley research evaluation exercise conducted recently on two aspects of rare-earth technology currently being investigated by CSIRO Divisions: processing of ores containing rare earths, and the fabrication of rare-earth magnets.

The recommendations were a qualified 'thumbs down' to research into processing and a 'thumbs up' to magnet research.

Undeterred by this early setback, the conference got under way for a 12-hour 'Talkfest' on rare earths, defined on this occasion as the lanthanide elements La to Lu, plus Sc and Y.

The keynote speaker, Dr Patricia Watson (El du Pont de Nemour, Wilmington, Delaware), an expatriate Australian who graduated in chemistry at ANU, presented a first-class overview of the history, economics and technology of the rare earths. She commenced with a reference to the Finnish chemist, Gadolin, who in 1794 began it all by extracting yttria (Y₂O₃) from the mineral gadolinite, and she concluded with references to work done within the past few weeks on high-temperature superconductors containing rare earths. Dr Watson gave a brief summary of the basic chemical properties of rare earths - at which stage the CSIRO Chairman departed - and followed on with an introduction to the principal mineral sands containing rare earths: monazite (La, Ce)PO₄, bastnaesite (La, Ce)FCO₃ and xenotime YPO₄. She also pointed out that the one thing that these metals are not is rare: their combined abundance in the earth's crust is one-hundredth of that of carbon! Their 'rare' quality relates to the extreme difficulty of separating them from one another, wherein lies their commercial value, ranging up to US$7050 per kg for Eu.

Dr Watson deftly surveyed production costs and quantities, and discussed a range of present and potential applications.

Dr Greg Tegart (Department of Science) then outlined the role he saw for government as the largest source of research funding in the country and as a custodian of a continuing basic-research infrastructure capable of meeting the many long-term problems that industry is deterred from financing. He referred to the Department's 'Rare Earth Working Party' under the guidance of the Seminar Chairman, Norton Jackson (Poseidon Ltd) and expressed the hope that, despite the 'gleaming tone' of the CSIRO/McKinley study, the meeting would identify legitimate areas for Australian research and development in both the processing and application of rare earths.

Dr Glen Deacon (Monash University) gave an exhaustive presentation on the chemistry of the rare earths. His bewildered audience recovered while Don Patterson (AMDEL) and Dr David Koch (CSIRO Division of Minerals and Geochemistry) described, respectively, analytical techniques and a scientific view of rare earth extraction and separation.

The afternoon continued with a talk by Roy Towner (BMR) on Australia's position as the world's major producer (15%) of monazite, 95% of which comes from sand mining operations at Eneabba and Capel in WA. He also drew attention to hardrock deposits in WA and SA and to further substantial quantities of mineral sands at Horsham (Vic), in NSW and in Queensland. He made the interesting point that current Australian production of rare-earth minerals is solely as a by-product of the mining of rutile, ilmenite and zircon.

Dr Philip Brown (CSIRO, Melville) spoke as a private consultant, stressing the commercial aspects of rare earth production, marketing and technology. In an excellent presentation he emphasized the importance of the eight 'heavy rare earths' that constitute 6% of consumption by volume but 74% by value, compared with the 'light metals' that constitute 92% by volume but only 23% by value. He also stressed the sobering fact that Australia is the only major RE ore producer which does not own its own processing plant, and that recently announced plans for a processing plant in WA contain no Australian industrial input! This theme, the dominant role of the giant French industrial firm, Rhône-Poulenc, which has contracts for processing 90% of Australia's monazite production and which, conversely, relies on Australia for 90% of its monazite supply, was referred to throughout the meeting in tones of helpless frustration.

Carl Tyren (Lund Institute of Technology, Sweden) concluded the afternoon with a talk on 'giant magnetostrictive effects (relative length changes in rare earth rods of up to 2500 parts per million in a variable magnetic field). He gave a strong commercial plug for Terfenol D (TERbiunum FE from the US Naval Ordnance Laboratories) and showed a set of working demonstrations.

The conference dinner that evening was followed by a lighthearted, but very pointed, address from Sir Russel Madigan (CRA Ltd), who reminisced on the happy, carefree, careless, early days of sand mining in Australia, in which opportunities were lost and a host of small Australian sand mining companies went to the wall.

The second day was devoted to applications of rare earths. The introductory talk by Dr Peter Robinson (National Materials Technology Advisory Committee) concentrated on the ramifications of the Generic Technology Grants Scheme. Dr Robinson also outlined the criteria adopted by the Committee in selecting the first group of successful bidders from the 40-50 applications received.

Two speakers from the host CSIRO Division of Applied Physics, Drs John Cook and John Dunlop, described research work in progress to help revive the dormant (extinct?) Australian magnet industry, after which their colleague Dr John Bell surveyed the role of worldwide excitement about ceramic superconductors (eg La₂₋ₓSrₓBa₃Cu₄O₇₋y, and YBa₂Cu₃O₇₋y, where x, y and z are small, variable numbers) with transition temperatures up to 95 K, well above the boiling point of liquid nitrogen.

Keynote speaker Patricia Watson returned to devote her talk on rare earths in the chemical industry to an interesting survey of the structural properties (as they are at present known) of high-temperature superconductors. She speculated on the likely significance in the superconduction process of the 'two dimensional' and 'one dimensional' phases of CuO observed in the structure.

Dr Karl Foger (CSIRO Division of Materials Science and Technology) took us back to chemistry with a survey of the role of rare earths as catalysts and promoters, particularly as cheaper alternatives to the costly noble metals Pt and Rh. Dr Neil Ryan (ARL) spoke of the virtues of CeC3 in reducing by a factor of two the corrosion rate of aluminium exposed to NaCl.

Dr Tom Spurting (CSIRO Division of Organic Chemistry), brought back the gouse with a run-down on the 'business systems' approach which led the CSIRO/McKinley team to recommend that 'CSIRO should not proceed with further research in the areas of rare-earth processing without industrial partners'. Once again the shadow of Rhône-Poulenc was cast
over the meeting.

On the final afternoon Dr John Lowe (CSIRO Division of Applied Physics) presented his research philosophy and his ideas for rare-earth phosphors in the lighting industry. Prof Ken Taylor (University of NSW) described the manifold applications of rare earths in communications, both electrical and optical, and then added his contribution to the high-temperature superconductor debate by displaying some pieces of superconducting wire, literally hot from the UNSW furnace.

Dr Sydney Blaire (UNSW) described new applications for rare earths in metallurgy, and an overseas visitor Mr Guo Bosheng (Beijing General Non-Ferrous Research Institute, China) took the meeting up quite a different part by presenting results from Chinese agricultural experiments. These indicate that addition of water-soluble rare-earth salts at ppm level increases the growth rates of crops: rice (by 8%), peanuts (10%) and tobacco (15%).

The seminar closed with a panel discussion chaired by Prof Robert Street (University of WA), who expressed the feelings of the meeting by stressing the urgent need to increase Australian intellectual property in the rare-earth field by joint research efforts involving industry, the universities and the CSIRO. The discussion was notable for a difference of opinion between Dr John Cook (CSIRO/McKinsey Evaluation team) and panelist Richard Taylor on the extent to which the government adoption of rare-earth technology as a priority area for Australian R&D and, consequently, as a suitable area for directed research by CSIRO squares with the need expounded by the CSIRO/McKinsey team for a clearly identified industrial partner as a sine qua non for future CSIRO research in the field. On a more positive note, successful entrepreneur in high technology, Dr Doug Ford (Memtec Ltd) gave the meeting a pungent summary of therapeutic circumstances under which he would quite happily chance $1-2M on a reasonable project using rare earths in the bio-medical field.

So where did this leave us? No one expects instant answers from a two-day exchange of views and philosophies in the difficult area of potential collaborations between industry and the research community. Awareness of each other's views and problems has certainly been increased, and in achieving this the seminar was successful. We shall have to wait and see whether the seeds sown produce a flourishing crop of rare-earth-assisted research alliances in the future - to use a Chinese metaphor.

J.G. Collins
(who declares an interest as the Seminar co-ordinator for CSIRO)

* * *

Chief Executive of MONTECH PTY

Dr. Paul Hudson has moved to become Chief Executive of MONTECH Pty. Ltd. MONTECH is the technology, consulting and commercial arm of Monash University and aims to be the focal point of industry and business contact. Institutions or companies wishing to collaborate with Monash University and exploit the products and processes derived on campus should contact:

Dr. Hudson on 03-565-3038.

International Non-Ionizing Radiation Workshop

An International Non-Ionizing Radiation Workshop will be held in Melbourne at the National Science Centre, Clunies Ross House (191 Royal Parade, Parkville, Victoria, 3052) between 5th - 8th April, 1988. This Workshop will precede the International Radiation Protection Association Congress "IRPA-7" to be held in Sydney 10th-17th April, 1988.

The Workshop is a project of the International Non-Ionizing Radiation Committee of IRPA and will comprise a series of educational lectures and demonstrations intended to give a comprehensive overview of non-ionizing radiation physical characteristics, sources of concern, levels of exposure, mechanisms of interaction and reported effects of these fields and radiations with biological tissues, human studies, health risk assessment, national and international standards and protective measures. Special lectures and expert panels will discuss current topics of particular concern, e.g. epidemiological studies.

Aims
(i) Intended as an educational workshop where participants will be provided information on the established scientific literature so that informed discussion can take place on confirmed and unconfirmed reports and hypotheses.
(ii) Provide interaction with experts who are involved in the development of international standards.
(iii) Keep lectures at a level so that participants with only a basic science knowledge will understand, yet ensure that each topic is covered with comprehensiveness and depth.
(iv) Publish a workshop proceedings of all lectures which will form a basic, up-to-date texts of non-ionizing radiation protection.

For further information, contact
Dr C. ROY,
NIR Section, Australian Radiation Laboratory
Lower Plenty Road Yallambie, Victoria, 3058.

* * *

Institute of Metals and Materials Bicentennial Conference

In May 1988 the Institute of Metals and Materials will have the honour of hosting the Bicentennial conference in Sydney. The theme of this conference is "The material wealth of the Nation" and it is to be discussed in the economic environment that Australia finds itself today.

The conference will cover 11 distinct areas of concern:

1. Education Research & Technology Transfer
2. Physics of Materials
3. Thermal processing
4. Forming of metals
5. Casting of metals
6. Polymers
7. Ceramics
8. Castings and surface treatments
10. Materials Technology in Consumer Goods & Electronics
11. Biochemical materials

For further information contact:
W.A. Ingerson,
Institute of Metals & Materials,
P.O. Box 263, Bondi Beach, NSW, 2026.

LETTERS TO THE EDITOR

A Plea for Help

I am currently preparing a history of the Australian physics community to 1945. In conjunction with this I am compiling a biography of Australian publications in physics to that date, classified by author and including a brief biographical summary for each author listed. This bibliography is close to completion. I am hoping to see it published during 1988 as a contribution to the bicentennial celebrations. I am, however, having difficulty in establishing precise (or in some cases any) biographical details for some authors on my list. I am writing in the hope that members of the Institute may be able to help me. Any snippets of information at all would be most welcome. The names in question are as follows:

J.H.D. BREARLEY - B.Sc., B.E. (Syd.), 1895. Later an engineer with Sydney Tramways authority?
John HERLIHY - B.Sc., B.E. (Syd.), 1933.
Douglas N. LINNET - published a paper on antenna constants, 1934.
William Henry MASON - B.Sc. (Syd.), 1905. Lecturer at Sydney Technical College?
William Lindsay PRICE - Lecturer in physics, N.S.W. U. of Technology, 1952-?; P/I research officer, Radio Research Board?
A.B.B. RANCLAUD - Lecturer in physics, Sydney Teachers' College?
Ludwig RUMMEL - several papers on spectroscopy in the 1890s. Music teacher in Melbourne?
L.M. SIMMONS - Secondary school teacher, Sydney?
Glenny SMEAL - 1850 Exhibition scholar from U. Melb.
Lecturer in statistics, U. Leeds, to 1946. What about that?
T. Carlton SUTTON - M.Sc. (Melb.), 1910. Research scientist, Royal Arsenal, Woolwich?
L.S. THOMAS - radio engineer, AWA, ca. 1935.

R.W. Home, FAIP.
Professor of History and Philosophy of Science,
University of Melbourne,
Parkville, VIC. 3052.
Ph. (03) 344 6556.

Calculating Machines and Babbage

I read with interest the article by Dr. H.C. Bolton on pp. 38-40 of the Australian Physicist for March 1987; in particular I noted the photograph of the Odhner Calculator with the input register set to 3.14156. Paired with Bolton's mention of Babbage's work, this brought to mind the following happenstance.

None of Babbage's machines, either of the Difference Engine (arithmetic calculator) or the Analytical Engine (much more sophisticated programmable computer) varieties, were ever brought to a successful conclusion. There is no room here to go into details of the remarkable stories surrounding these devices, but the reader is referred to Anthony Hyman's recent biography (Charles Babbage: Pioneer of the Computer, O.U.P., 1982). In the latter part of the nineteenth century one of CB's three sons, Major-General Henry Provost Babbage, tried to construct the mill (or central processing unit) and the printing section of the Analytical Engine.

With difficulty, over a period of thirty years, HRB completed this portion of the device and in 1910 displayed it to the Royal Astronomical Society, of which his father had been one of the twelve founder members in 1820. The results shown here were reproduced, along with a photograph of the mechanism and a short article, in the 'Monthly Notices' of that society (vol. 70, pp. 517-520). These 'multiples of pi' might therefore be claimed to be the world's first computer printout: the very first drop in the deluge.

Those readers who are not yet entirely convinced that computers are an essential tool for every physicist will be delighted to learn that this print-out contained several errors; in fact every value is wrong (since the input value was in error) and three of the multiples contain additional mistakes due to a sticking of the mechanism. It is left to the reader to identify these (the errata were given on op. cit., p. 645). Whilst running over a computer programme which is giving results at variance with those expected it is useful to remember that this example implies that less than 1% of the errors are due to machine faults, and that improvements in computers since then will have rather reduced this figure.

As aforementioned, CB had three sons reaching their majority. The other two sons emigrated to South Australia around 1850 where one (Dugal Bromhead Babbage) was a currant farmer and the other (Benjamin Herschel Babbage) was chief engineer on the Adelaide to Port Adelaide railway; he had earlier trained with Isambard Kingdom Brunel. Later in the 1850's BHB led two exploratory expeditions to the northern parts of South Australia and became embroiled in a parliamentary inquiry due to his slow progress (see Bonyton's book on the Flinders Ranges). There is now a Mount Babbage in the Northern Flinders named for BHB; Babbage Island off of Carnarvon in Western Australia was

MULTIPLES OF PI

00001 03141592653589793238462643383
00002 062831853071795667469252867668
00003 09424779760769349715387930149
00004 12566370614359123953850573532
00005 157079632679498119231326195
00006 18849559215386594307753862982
00007 2199114857512842669236503661
00008 2513371228718265907701147064
00009 282753338623080491461537901447
00010 31415926535897932384626433830
00011 3455718183948761562309072713
00012 3769911184307739861551720596
00013 40840704346667182100014365979
00014 4398229715025695338477007362
00015 47123889803846784576959360754
00016 5026548245745631815402294128
00017 53407075111026315035864937511
00018 56548667764616089292227580894
00019 59690260418205881350790224277
00020 62831853071795667469252867660
00021 6597344572535844800715511042
00022 69115038738975221264178154426
00023 72256651032565014484640797809

Specimen of work printed by the machine.
LETTERS TO THE EDITOR

named for CB by Sir George Grey, and at one time there was a Mount Babbage, also christened for CB but since renamed, in New South Wales.

When CB died in 1871 BHB was working as a surveyor on the Overland Telegraph. He immediately shipped to London and returned to Adelaide with many of his father's notes and papers, and various parts of the Difference and Analytical Engines. A scandal in the 1890's led to most of the family moving to New Zealand, where Garry J. Tee of the University of Auckland has managed to (almost literally) unearth much of this material (see the Annals for the History of Computing, 1983). However, there may still be items in Australia which would be of great interest to historians of computing and physics (CB was a great polymath); the author would be pleased to hear of any clues as to their location.

Duncan Olsson-Steel,
Department of Physics,
University of Adelaide.
(During 1987: Lund Observatory, Sweden.)

Antarctica

I was amazed at the number of inaccuracies in such a short item as the one entitled "Higher Profile in Antarctica" on page 68 of the April 1987 issue of The Australian Physicist. Australia claims about 42 percent of the Antarctic continent, not two-thirds. The two new bases bring to 5 the number in Antarctica, not 6. I presume the sixth proposed would be Macquarie Island which is not in the Antarctic.

In 1911-14, Mawson led an Australasian expedition, not an Australian one.

I do not dispute the claim to a higher profile.

Clarrue McCue F.A.I.P.,
60 Jeannie Cres,
Berkeley Vale,
NSW 2259

Editorial Comment: I would like to thank Mr McCue for his corrections. The information came via another journal. Perhaps A.I.P. members in the Antarctic Division would like to comment further.

FASTS

Recently a Federation of Australian Science and Technology Societies (FASTS) document headed "Industry-Education for Science and Technology" passed my way. I gather from its introduction that it is an outline of how FASTS can be a useful resource to the government and industry to help educate sufficient numbers of scientists and technologists for the future to save Australian Industry and the failing Australian economy. It presents various facts and figures about supply and demand of graduates and postgraduates trained in various fields. The AIP is a member of FASTS and Prof. Fred Smith is the FASTS chairperson. I am concerned that the document gives a misrepresentation of the problems of employment in science and technology.

For example, in discussing the supply of physicists with PhDs, it states that there are 50 graduates each year for 150 jobs (based on advertisements and university statistics) and then concludes that there is an undersupply of physics PhDs. I doubt that the FASTS committee has been job hunting lately because they have failed to include the number of physicists who are in the job market at the end of their limited term positions. As most PhD graduates do not get indefinite appointments for about 6-9 years after completion of their degree and only about 10 out of 150 jobs are permanent, a very different picture is drawn.

WORST CASE: Average 9 years to get a permanent job
10 permanent jobs per year
50 new physics PhDs enter the job market
3x40 physicists re-enter the job market

Then the number of physicists in the job market is
50 + 3 x 40 = 170
The best case of 6 years to get a permanent job
50 + 2 x 40 = 130

On average the supply is meeting demand. Even if these figures are out by 20% this is a very different picture to 3 jobs for each graduate! Furthermore, if a PhD graduate works for CSIRO on a 3 year term, at the end of the term they would be earning at least $30k. If they were to take up an ARGO postdoc or equivalent in a university at $26k, they would be receiving a significant drop in salary, not an attractive prospect. Many would rather move into fields not directly relevant to their expertise or go overseas.

Another example is that some Biotech postdoctoral positions are remaining vacant. The FASTS committee have forgotten that most university postdocs offer only $24k after about 8 years training. Not a very well paid position especially at a time when most PhD graduates would like to think about catching up in their quality of life with their non-postgraduate peers.

The report also stated that there was competition in expanding sectors eg Biotechnology industry, attracting people away from health research areas. FASTS has failed to realise the off-handed way that health research is carried out. At the Prince Alfred Hospital in Sydney, a cancer research unit with about 20 PhDs has been reduced to about 3 PhDs in the last 2 years because funds have been cut, grants not renewed as most health research scientist positions are funded by the grant at about $18k! With the arrival of biotech industries, this underpaid crowd with a piecemeal existence have finally been offered jobs with somewhat better conditions.

FASTS please watch what you say about job markets. It is necessary that you take everything into account and not just try to lift effective-student-ratios. Rather we need to push for better rates of pay provided by grants schemes so that the job is financial as well as intellectually rewarding.

Maybe FASTS should also include some of the lower echelons of the scientific community on its committee to present a more balanced view point.

Dr. Catherine Foley,
CSIRO Division of Applied Physics,
Lindfield.

Re TAP Editor

The Editor would like to announce that the Vice President of the AIP, Prof. A. G. Klein is in charge of finding the next editor for The Australian Physicist. I would therefore like to suggest that all letters and ideas on the subject be forwarded to him. This will make his task easier.
Address: Prof. A. G. Klein,
Science Centre, 35-43 Clarence St,
TEACHING

Australia's involvement in the International Physics Olympiads

R. Jorey, School of Applied Science, Canberra.

But for two isolated occurrences and a coincidental link Australia would not yet be in the International Physics Olympiads. The first was the intervention by Fred Smith of an article on the British Physics Olympiad in the Bulletin of the Institute of Physics, London. The second was the writer's appointment to the committee of the International Mathematics Olympiad 1988 and the requirement to attend the International Mathematics Olympiad in Warsaw in July 1986.

The link was a letter from Fred Smith saying "Why aren't we in this?" which reads, as you will know if you have ever had a letter from Fred, "Do something about this." So it was done.

The International Physics Olympiad is an international competition between teams of student physicists. Students must not have entered University and must be 20 years of age or younger. The Olympiad this year in Jena, DDR, will be the 18th.

The competition originally began in Poland in 1967 as an Eastern European event but was extended in 1982 to other countries. Table 1 gives the representation.

Each nation participating sends a team of up to 5 students, a leader and a deputy leader. Teams remain on location for about one week and are entertained by the host nation as appropriate.

Each student sits for one theory paper and one laboratory paper both of up to five hours duration. Papers are set by the host country in English, Russian, and the host language. On the eve of the examination, the paper is given to leaders for criticism. After several hours of discussion the papers are agreed upon and each leader then translates the paper into his own language, types the paper and photocopies it. This often takes most of the night. During this time the leaders are quarantined from the students.

Once the paper has been completed by the students it is marked by local markers who consult with the leaders to ensure that the question is correctly assessed.

Medals are awarded on individual performance and are of the usual gold, silver and bronze. In 1986, in London, 3 gold, several silver and around 20 bronze were awarded. Special prizes are awarded for original solutions and for first-time teams. Teams performing best in the International Physics Olympiad are usually the UK, with its highly specialised year 12 and the USSR.

Results are not made public but are, of course, known to the organisers and to the leaders of the individual teams. There are nations who compete annually with little expectation of scoring more than a handful of marks and no possibility of a medal. As can be seen by the number of gold medals, very few students are able to complete the papers correctly.

It would appear that all participating nations have their team sponsored by their government with the exception of the UK and now Australia. Large sums of money are spent in preparing teams especially by the Eastern European nations. Since many Eastern European nations have limited foreign exchange the Olympiads have developed so that all expenses in the host country, including pocket money, are paid by that host country. Students can then travel by their national airline and avoid incurring the need for any foreign currency.

UK was given the 17th International Physics Olympiad fairly late and for a long time they found it difficult to raise the necessary funds. They were fortunate enough to find a principal sponsor, R.M. Nimbus Computers, about six months before the event and were able to mount the 17th International Physics Olympiad.

The driving force in Britain is Dr Cyril Isenberg from the University of Kent at Canterbury who has prepared the UK teams for some years.

The five hour theory paper from the 17th International Physics Olympiad is attached to this article. The first half of the laboratory examination used a spectrometer to identify the fifth order rainbow in a drop of water. The second half was a computer simulation experiment but these are not to be included in future years.

Once the examinations are over the students are taken on several expeditions to locations of interest to physicists. In Britain they were taken to Oxford, the Rutherford-Appleton Laboratory, the Greenwich Maritime Museum, the Houses of Parliament and the Royal Institution where they were shown Faraday's original laboratories. Several lectures of particular interest to this group of students were also included.

The week closes with a formal award ceremony in English and Russian led by whatever dignitaries are available to the organisers.

Preparation in nations varies greatly. The British elimination paper sent to all interested schools in the UK is more difficult than the international competition. Dr Isenberg's comment was that it has to be that difficult to find the right people. Members might like to refer to the paper by Isenberg in Physics Education to see what is meant by difficult. (Physics Education, Vol. 20, 1985, pp. 218-226.)
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The U.K.'s preparation and fund raising was marred by a group of people who declared the whole event to be "elitist" and demanded that the money would be better spent on the improvement of physics education in general in Britain. Since the amount in question is about 40,000 pounds one wonders what this could do if spread over the thousands of physics students in Britain. A protest march on the examination was feared. Isenberg's attempts at raising money were hindered by this and certain big firms who would have given him money declined to do so.

The opponents fail to distinguish between "elitist" and "excellence". The whole idea of the International Physics Olympiad is to encourage excellence in the subject of physics, in its study and in its teaching. By recognising excellence one can lift the standard throughout the subject.

The writer attended the 17th International Physics Olympiad in London, held at the Harrow School in July 1986 as an observer with an expectation that Australia might field a team in 1989.

This seemed not unreasonable at the outset but after four days I was easily persuaded that 1988 would be a reasonable target. By the time the International Physics Olympiad was completed I was convinced that 1987 was not unrealistic.

At the final meeting the delegates amend any rules necessary and close by inviting all participating nations, together with those who sent observers, to compete in the following year. Australia had entered for 1987. No time was wasted in passing this information to Fred Smith who obtained the support of the National Executive of the Institute and by the time the writer reached home a letter was on his desk.

A note on locations is of interest. Apparently all dates up to the end of the century have been allocated but in 1986 it was found that the intended host for 1988 had withdrawn. The future of the 20th International Physics Olympiad was very much in doubt since most potential host nations were already committed to a future year. When it became clear that Australia was an intending participant more than one glance was made toward the Australian observer wondering if Australia 1988 was possible. Fortunately the Austrian delegate was able to secure an understanding from his government to advance the date from 1992 and the 1988 International Physics Olympiad will be in Austria.

The AIDC National Science Summer School Council agreed to lend its name to the attempts to enter a team in 1987. A successful approach was made to the Australian Bicentennial Authority to have the project declared Endorsed Bicentennial Activity in 1988 with the 1987 expedition being a pilot programme to ensure an invitation for 1988.

Considerable local argument was mounted against an Australian entry in 1987 based on the premise that we were unprepared. This might be true but it is hard to see how we can become better prepared than by actually attending. If Australia does not compete in 1987 there will be no more information available for the 1988 Olympiad than there is now and no more incentive in terms of past achievement. Although there will be additional lead time to select students there will still be no experience in selection procedures. It is also possible that the invitation might lapse if a team is not sent in 1987. It was agreed, therefore, to send a team in 1987 as a pilot team.

It was decided that students selected for the AIDC National Science Summer School provided a pool of the top level students from which we might select a team. These students were about to enter year 12 and were thus of the right age group.

Members of the ACT branch of the Australian Institute of Physics volunteered to set and check a paper which was done very much in haste. This was sent to the 250 students about to attend the AIDC National Science Summer School and by mid December, 81 responses were received. From these, 12 correctly completed papers were identified.

A simple open-ended experiment involving a compound pendulum was set up in the CCAE Physics Laboratories and each of these 12 students was given 3 hours in which to perform the experiment. Since the AIDC National Science Summer School is not a competitive organisation each student was advised individually of the time of the experiment, carried out the experiment when no other students were present and was asked to tell no-one of the experiment.

From these 12 candidates 3 were found to have an experimental ability slightly ahead of the others. The team that became Duncan Waite, 16, of Toowoomba Grammar School, NSW, Jaime Schirmer, 17, of Biloea State High School, QLD and Matthew Sorell, 17, of St Peters College, SA.

Geoff Jackson, a physics and engineering student at the University of NSW offered his services as deputy leader.

The first and major need was money. At least $3,000 per person was required for fares and general costs which, with some of the already incurred central costs, brought the total over $16.500. $20,000 would have been more realistic but became quite impossible.

Each student was set to raise his own costs and to assist letters were sent to the local newspapers, schools, Rotary clubs, parliamentarians and others for each of the team to the credit of the local communities each of the boys managed to raise a substantial portion if not all of the amount required.

The problem for the leaders was that no community is anxious to support an administrator and the costs necessarily had to come from the non-existent central funds or from their own pockets which is hardly acceptable.

Together with the invitation from the DDR, a letter from Susan Ryan, endorsement by the Bicentennial Authority and support from the AIP, dozens of letters were sent to companies around Australia asking if they would wish to sponsor the exercise in 1988 as a Bicentennial Project.

Unfortunately the answers were all the same. Great project, good luck, but unfortunately for one of many reasons we can't be in it. Where possible a follow up letter was sent asking for a modest donation to set the project on its way.

It is not hard to understand why anyone is reluctant to invest money in such a project as there is absolutely nothing to show but promises and a few letters of encouragement.

Once it is possible to return home with a team which has performed creditably and attract some national and international attention it might be possible to interest businesses in contributing.

So on June 27th 1987 a team of three Australian student physicists and two leaders leave by Lufthansa to attend the 18th International Physics Olympiad, having raised most of the costs themselves, having madly crammed physics for four months with the help of the best available local resources and being rather afraid of what they might meet. They are determined, however, to represent Australia well even if their performance is not about to set the world on fire and, most important, to pave the way for future teams from Australia.

Thanks must be expressed at this point to the executive and members of the Australian Institute of Physics, the Council of the AIDC National Science Summer School and to those members of the volunteer staff of the AIDC National Science Summer School, Geoff Jackson, Tim Sendon and especially Greg Lane for their assistance in having this team selected and prepared.

And where do we go from there?

In March 1987 an examination paper was sent to all secondary schools in Australia inviting them to set it for their best year 11 students. Science teachers were asked to do this by May 15th 1987 and then to identify any students who are able to complete the paper to their satisfaction. Sufficient time was given for the teachers to set extra work for their students if the paper was beyond the curriculum at that point.

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These names were to be sent to Canberra by 15th June. The Schools of each of these students together with those of students who fell in the top 1% of the IESS Australian Schools Science Competition set for year 10 in 1986 will then be sent the qualifying examination to give to these students in September or October 1987. Hopefully there will be between 300 and 500 students in this category. Exams are to be set on a common date across Australia, marked by the science teachers and returned to Canberra for moderation. From these a small group of say 50 will be chosen to sit for a final examination, both theory and laboratory, either at the end of 1987 or early in 1988. This will allow the members of the 1988 team to go to Austria to be chosen.

A parallel operation will be mounted in Chemistry using the results of the Chemistry Week quiz and the ASSC to choose the four students to go to Helsinki for the 1988 International Chemistry Olympiad.

On April 29th 1987 representatives of the Australian Academy of Science, the AIP, the RACI and the CCAE met and formed the Australian Science Olympiads as an incorporated body. This body will in future be responsible for all activities involving Australian participation in the International Physics Olympiads and the International Chemistry Olympiads.

The contributions asked of the AIP will be as follows:

1. A problems committee, initially located in Canberra, who would set the preliminary, qualifying and final papers.
   The setting of the last paper will require considerable skill to enable the correct team to be chosen.
2. A nationwide advisory committee who would:
   (i) Check the papers;
   (ii) Supervise the final examination for the small number of students who might sit from their city; and
   (iii) Be willing to have their names associated with the project as senior advisory committee.
3. An assessment committee who would be required to make the final decisions.
4. Persons who would be willing to contribute to a training scheme for members or potential members of future teams. The latter has yet to be discussed.

Should any members or friends of the AIP be willing to act in any of these capacities they are asked to contact the writer at the address given. It is pleasing to have already received several offers of assistance from various parts of Australia even though the only information to date has been word of mouth.

Finally there remains the question of money. If at any time members can identify any potential sponsor who is willing to assist Australia's entry into the International Physics Olympiad please contact the writer. The sum of $30,000 is needed in each discipline in 1988.

Examination Paper

International Physics Olympiad 1986

1. A plane monochromatic light wave, wavelength $\lambda$ and frequency $f$, is incident normally on two identical narrow slits, S and M, separated by a distance $d$, as indicated in the figure. The light wave emerging at each slit is given, at a distance $x$ in a direction $\theta$ at time $t$, by

$$ y = a \cos \left( 2\pi (ft - x\lambda) \right) $$

where the amplitude $a$ is the same for both waves. (Assume $x$ is much larger than $d$)

(i) Show that the two waves observed at an angle $\theta$ to a normal to the slits, have a resultant amplitude $A$ which can be obtained by adding two vectors, each having magnitude $a$, and each with an associated direction determined by the phase of the light wave.

Verify geometrically, from the vector diagram, that

$$ A = 2a \cos \beta $$

where

$$ \beta = \frac{\pi}{\lambda} \frac{d \sin \theta}{\lambda} $$

(ii) The double slit is replaced by a diffraction grating with $N$ equally spaced slits, adjacent slits being separated by a distance $d$. Use the vector method of adding amplitudes to show that the vector amplitudes, each of magnitude $a$, form a part of a regular polygon with vertices on a circle of radius $R$ given by

$$ R = \frac{a}{2 \sin \beta} $$

Deduce that the resultant amplitude is

$$ a \frac{\sin N\beta}{\sin \beta} $$

and obtain the resultant phase difference relative to that of the light from the slit at the edge of the grating.

(iii) Sketch, in the same graph, $\sin N\beta$ and $(1/\sin \beta)$ as a function of $\beta$. On a separate graph show how the intensity of the resultant wave varies as a function of $\beta$.

(iv) Determine the intensities of the principal intensity maxima.

(v) Show that the number of principal maxima cannot exceed

$$ \left( \frac{2d}{\lambda} + 1 \right) $$

(vi) Show that two wavelengths $\lambda$ and $\lambda + \Delta \lambda$, where $\Delta \lambda \ll \lambda$, produce principal maxima with an angular separation given by
\[ \Delta \theta = \frac{n \Delta \lambda}{d \cos \theta} \]  
where \( n = 0, \pm 1, \pm 2, \ldots \).

Calculate this angular separation for the sodium D lines for which

\[ \lambda = 589.0 \text{ nm}, \quad \lambda + \Delta \lambda = 589.6 \text{ nm}, \quad n = 2 \]

and \( d = 1.2 \times 10^{-6} \text{ m} \).

(reminder: \( \cos A + \cos B = 2 \cos \frac{A-B}{2} \cos \frac{A+B}{2} \)).

2. Early this century a model of the Earth was proposed in which it was assumed to be a sphere of radius \( R \) consisting of an homogeneous isotropic solid mantle down to radius \( R_c \). The core region within radius \( R_c \) contained a liquid.

\[ \theta = \angle EXO \]

where \( O \) is the centre of the Earth.

(i) Show that the seismic waves that travel through the mantle in a straight line will arrive at \( X \) at a time \( t \) (the travel time after the earthquake), given by

\[ t = \frac{2R \sin \theta}{v}, \quad \text{for} \ \theta \leq \arccos \left( \frac{R_c}{R} \right), \]

where \( v = v_p \) for the P waves and \( v = v_s \) for the S waves.

(ii) For some of the positions of \( X \) such that \( \theta > \arccos(R_c/R) \), the seismic P waves arrive at the observer after two refactorions at the mantle-core interface. Draw the path of such a seismic P wave. Obtain a relation between \( \theta \) and \( i \), the angle of incidence of the seismic P wave at the mantle-core interface, for P waves.

(iii) Using the data

\[
\begin{align*}
R & = 6370 \text{ km} \\
R_c & = 3470 \text{ km} \\
v_p & = 10.85 \text{ km s}^{-1} \\
v_s & = 6.31 \text{ km s}^{-1} \\
v_{cp} & = 9.02 \text{ km s}^{-1}
\end{align*}
\]

and the result obtained in (ii), draw a graph of \( \theta \) against \( i \). Comment on the physical consequences of the form of this graph for observers stationed at different points on the Earth's surface.

Sketch the variation of the travel time taken by the P and S waves as a function of \( \theta \) for \( 0 \leq \theta \leq 90 \) degrees.

(iv) After an earthquake an observer measures the time delay between the arrival of the S wave, following the P wave, as 2 minutes 11 seconds. Deduc the angular separation of the earthquake from the observer using the data given in Section (iii).

(v) The observer in the previous measurement notices that some time after the arrival of the P and S waves there are two further recordings on the seismometer separated by a time interval of 6 minutes 37 seconds. Explain this result and verify that it is indeed associated with the angular separation determined in the previous section.

3. Three particles, each of a mass \( m \), are in equilibrium and joined by unstretched massless springs, each with Hookes Law spring constant \( k \). They are constrained to move in a circular path as indicated in the figure.

(i) If each mass is displaced from equilibrium by small displacements \( u_1, u_2, \) and \( u_3 \) respectively, write down the equation of motion for each mass.

(ii) Verify that the system has simple harmonic solutions of the form

\[ u_n = a_n \cos \omega t, \]

with accelerations \(-\omega^2 u_n\), where \( a_n \) (n=1, 2 and 3) are constant amplitudes, and \( \omega \), the angular frequency, can have 3 possible values,

\[ + \omega_1 \sqrt{3}, \quad - \omega_1 \sqrt{3} \quad \text{and} \quad 0, \]

where \( \omega_1^2 = k/m \).
(iii) The system of alternate springs and masses is enlarged to N particles, each mass \( m \) is joined by springs to its neighbouring masses. Initially the springs are, unstretched, in equilibrium. Write down the equation of motion of the \( n \)th mass (\( n = 1, 2, \ldots N \)) in terms of its displacement and those of the adjacent masses when the particles are displaced from equilibrium.

\[
\text{u}_n(t) = a_s \sin \left( \frac{2n\pi}{N} + \phi \right) \cos \omega_s t
\]

are oscillatory solutions where \( s = 1, 2, \ldots N \), \( n = 1, 2, \ldots N \) and where \( \phi \) is an arbitrary phase, providing the angular frequencies are given by

\[
\omega_n = 2\omega_s \sin(\pi/n)
\]

where \( a_s \) (\( s = 1, \ldots, N \)) are constant amplitudes independent of \( n \).

State the range of possible frequencies for a chain containing an infinite number of masses.

(iv) Determine the ratio

\[
\text{u}_N / \text{u}_{N+1}
\]

for large \( N \), in the two cases:

(a) low frequency solutions
(b) \( \omega = \omega_{\text{max}} \) where \( \omega_{\text{max}} \) is the maximum frequency solution.

Sketch typical graphs indicating the displacements of the particles against particle number along the chain at time \( t \) for cases (a) and (b).

(v) If one of the masses is replaced by a mass \( m' \ll m \) estimate any major change one would expect to occur to the angular frequency distribution.

Describe qualitatively the form of the frequency spectrum one would predict for a diatomic chain with alternate masses \( m \) and \( m' \) on the basis of the previous result.

Reminder

\[
\sin(A+B) = \sin A \cos B + \cos A \sin B
\]

\[
\sin A + \sin B = 2\sin \left( \frac{A+B}{2} \right) \cos \left( \frac{A-B}{2} \right)
\]

\[
2\sin^2 A = 1 - \cos 2A
\]
TEACHING

The Format

Physics teachers in over forty schools each choose their four or five top physics students, and bring them to Armidale for a busy two days of lectures and laboratory sessions, designed to stimulate their interest in Physics and to broaden their view of Physics beyond the H.S.C. curriculum.

The format has changed little over five years of Winter Schools, and is made up of five 50-minute lectures, four 50-minute laboratory sessions and a 50-minute tour of the Physics Department. The lectures and laboratory experiments presented in July 1986 are listed below:

Lectures
Lasers - Ancient and Modern: Prof. S.C. Haydon
Theories of Forces and Motion: A/Prof. C.A. Sholl
Mechanics in Everyday Life: Dr A. I. McIntosh
Exotic Stellar Remnants: Dr B.M. Seppelt
Thunder and Lightning: A/Prof. G.A. Woolsey

Laboratory Experiments
Resistance thermometer  Viscosity
Radioactivity  Telescope
Newton's rings  Laser optics
Spectrometer  Potential distribution
Air track  Millikan's experiment
Electronics  Ultrasoundics

Each lecture is designed to be stimulating, instructive and entertaining, and substantial effort goes into preparation, particularly in respect of demonstrations and audio-visual aids. At the beginning of the first lecture, we advise students to forget about taking notes, but rather to sit back, listen, learn and enjoy. During each laboratory session, students are distributed amongst twelve different experiments (see above) and, on average, we prepare six sets of each experiment. This arrangement fully taxes the resources of the department.

Students work in pairs - each student is paired with a different student for each of his or her four experiments, never with a student from his or her own school, and each litre is covered by each school. Teachers are free to join the laboratory work as they please. The laboratory sessions emphasise the setting up of equipment, together with the recording and analysis of results, rather than simply observation. During each of the five time-slots set down for laboratory work, a fraction (1/5) of the students, plus some teachers, goes on a tour of the workshops and research laboratories of the Physics Department. Research students act as guides to provide basic descriptions and explanations of the research in progress.

An important modification to the original format, introduced since the third Winter Physics School at the suggestion of the teachers, is the addition of one or two sessions specifically for the teachers. In these, held concurrently with the laboratory sessions, members of the staff of the Physics Department talk and lead discussion on topics chosen in consultation with teachers. The teachers' sessions have provided advice and resource material in areas such as demonstrations in Physics, use of microcomputers in teaching, and optics and lasers; the latter topic having been chosen because it is a new elective of the H.S.C. syllabus. Each student and teacher is provided with a Winter School book which includes details of the programme and session times, abstracts of the lectures, and laboratory notes on all twelve experiments. Each student book is personalized in that it includes an individual code assigning the experiment (or tour) to be attended during each laboratory session.

We have designed the Winter Physics School for year 11 students rather than for those in year 12. This was done mainly because we did not want to be constrained by the H.S.C. syllabus, preferring to maintain the freedom to exploit the full range of talent, expertise and resources available within the department. This, in turn, has allowed us to present Physics as a challenging and exciting discipline. It is unlikely that this approach would be appreciated by H.S.C.-minded year-12 students, especially in mid-July. At this time of the year, the other hand, year-11 students are beginning to understand and appreciate many basic physical concepts.

In 1986, the fifth Winter Physics School was attended by 170 students and 40 teachers from a wide area of northern N.S.W. The locations of the participating schools are shown on the map of N.S.W., and students and teachers travel distances of up to 500 km to attend. Because so many schools and students wish to be involved, we have had to restrict the number of participants from each school to four or five students and one teacher; the restriction exists because of limitations in lecture theatre seating and laboratory space.

Not only do we expose the high-school students to a tight academic schedule, but we also introduce them to some of the social aspects of University and residential college life. Students and teachers are accommodated during the two days of the Winter School in one of the University colleges (at their own expense), and are entertained in the evening by organized activities at the Sports Union, and by sessions of observational Astronomy.

Responses, Conclusions and Results

Our primary goals in establishing and running the Winter Physics School are (i) to motivate high-school physics students, so that more may be encouraged to study physics at the University level, either at the University of New England or elsewhere, and (ii) to stimulate their teachers, many of whom are not physics graduates, so that they become better, and more interesting, teachers of physics. It is difficult to assess how successful we have been in achieving these goals. The responses from both students and teachers indicate that we have struck the right format, and although clearly every student does not understand everything that he or she is involved in at the School, there is more than enough to send each student (and teacher) back to school with renewed interest in, and enthusiasm for, Physics. The students are very receptive in lectures, and extremely appreciative of being able to work with sophisticated equipment not available to them at school. For our part, we and our colleagues in the Physics Department revel in the atmosphere engendered by keen students, busy laboratories and full lecture theatres.

For the first few years of the Winter School, we made no attempt to canvass for students to enroll as undergraduates, preferring to let students and teachers judge the environment and facilities at the University of New England for themselves. In 1986, however, we were rather less inhibited, and did advertise some of the more unique aspects of life at the University of New England, such as the College accommodation, the relatively small classes and the close contact between staff and students. We also provided information on our courses in Physics, Astronomy and Electronics and Microprocessors.

The amount of work required to run the Winter School is considerable and its continued success has only been possible because just about every member of the staff of the Physics Department, (academic, technical and secretarial) plays a part. Much of the laboratory demonstrating is done by research students, honours students and third-year physics students. In 1986, three of the latter group had been participants in our first Winter Physics School in 1982.

Perhaps one of the measures of the success of our venture is the interest now being shown by other departments of the Faculty of Science in running similar schools.

The Australian Physicist, Vol. 24, 1987-Page 117
And Who Shall Teach Them What
L.G. Little and I.J. Cooper, Sydney Institute of Education.

Statistics based on examination details published by the New South Wales Senior Schools Board for the six years since 1980 (Table 1) show that physics has consistently attracted a little less than 30% of the total Higher School Certificate candidates and a slightly lower percentage of total HSC science candidates. When it comes to attracting students, physics does less well than both chemistry, with about 30%, and biology which accounts for approximately 40% of the total candidates at the HSC level.

While the effects of newly introduced rules for the 1986 Higher School Certificate on candidates are yet to be determined, it is clear from the above statistics that the employment prospects for physics teachers should be at least steady. At the same time the apparent status of physics amongst the other HSC sciences, as viewed by potential candidates, provides little cause for complacency. Physicists and physics educators will do well to consider the quality and popularity of physics at the HSC level and the provision of teachers capable of teaching it with confidence and conviction.

It is clear that physics teachers have a great deal to learn from cognitive psychologists and science educators when it comes to understanding the processes through which learners come to a sound knowledge of any subject, including physics [Head, 1982]. Since the basic work of Driver [1973], it has been widely shown that children undertaking instruction in science hold 'private' or 'pre-instructional' understandings of scientific concepts. These understandings have been variously labelled as 'children's science', 'intuitive science', 'alternative frameworks' and even as 'misconceptions' and appear to relate to the learners 'life-world' perception of things rather than to any formal scientific instruction concerning these things [Preece, 1984].

While the early studies of learning processes were generally conducted with children - hence the descriptor 'children's science' - studies conducted with tertiary students show this to be a somewhat inappropriate descriptor. McCloskey et al [1983] have shown that tertiary students hold 'intuitive concepts' which are inconsistent with those of fundamental Newtonian mechanics and a number of workers have found that not only do pre-instructional concepts persist into the learners' tertiary learning experiences but also that students often prefer them to the correct scientific concepts which teachers are striving to impart [Viennot, 1979; Clement, 1982; Hewson and Hewson, 1983; Brumby, 1984]. While Solomon [1983] has summed up 'children's science as 'messy, contradictory and obstinately persistent', the authors have found evidence for the persistence of, and preference for, pre-instructional concepts in university graduates who have completed a one-year course in teacher education and are about to become teachers. Some will become physics teachers!

The majority of science graduates entering the one-year Post Graduate Diploma in Education (i.e., DipEd) course at Sydney Institute of Education will include in their course either 33 hours or 21 hours of learning how to teach HSC physics. If they are considered to be physics majors, and this can include graduates with as little as two years of physics in their degree, they will do the 33 hour course. If they possess less physics than this, which includes those with none at all, they will do the 21 hour course. While graduates with a major in physics will almost certainly teach it at a senior school level it is not uncommon to find graduates in the 21-hour group accepting positions in which they are required to teach HSC physics. Graduates from both groups will necessarily teach physics topics within the junior school science syllabus i.e. Years 7-10. There is no attempt to teach physics content to any of these students during their one-year course at Sydney Institute, except where this content is used to illustrate a particular teaching technique, practical skill or curriculum development. Table 2 shows the distribution, according to the major discipline professed, for all DipEd science students entering this program since 1980.

Towards the end of the 'learning to teach physics' component of their course the students are given a short test on their understanding of basic concepts in kinematics. The test, which has been given to all DipEd students for whom

<table>
<thead>
<tr>
<th>Table 1</th>
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<td>( % shown in the lower half of the table represent percentages of the Total Science Candidates)</td>
</tr>
<tr>
<td>Total candidates</td>
</tr>
<tr>
<td>Total science candidates*</td>
</tr>
<tr>
<td>n %</td>
</tr>
<tr>
<td>Physics</td>
</tr>
<tr>
<td>Biology</td>
</tr>
<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Geology</td>
</tr>
<tr>
<td>Increase in total candidates 1980-85 approx 18%</td>
</tr>
<tr>
<td>Increase in total science candidates 1980-85 approx 12%</td>
</tr>
<tr>
<td>Note: Students may be candidates for several sciences.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
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<tbody>
<tr>
<td>Major science discipline for students entering the Graduate Diploma in Education program at Sydney Institute of Education</td>
</tr>
<tr>
<td>Total No</td>
</tr>
<tr>
<td>Physics*</td>
</tr>
<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Biology</td>
</tr>
<tr>
<td>Geology</td>
</tr>
</tbody>
</table>

* includes students having at least Physics II in their degree. |
the authors have had responsibility since 1983, requires them to sketch displacement/time, velocity/time and acceleration/time graphs for the motion of a vertically projected missile from the time just after it leaves the hand to the time just before it has returned to the hand. They are told that air resistance may be ignored in this problem. Each graph has been marked out of 5 on the basis of its general shape and the extent to which it correctly shows the initial and final values of the dependent variable. For purposes of analysis the students have been divided into three groups:

- **Group 1** No university physics
- **Group 2** 1 year university physics (including Physics I for Life-Sciences)
- **Group 3** At least Physics II.

Results for the three groups are shown in Table 3.

**Table 3**

Results on Understanding Kinematics test. (Diploma in Education Students 1983-1986)

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>displacement</th>
<th>velocity</th>
<th>acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No physics</td>
<td>24</td>
<td>4.5</td>
<td>3.5</td>
<td>0.75</td>
</tr>
<tr>
<td>2. PhysI/Life Sc Physics</td>
<td>35</td>
<td>4.0</td>
<td>3.0</td>
<td>0.5</td>
</tr>
<tr>
<td>3. At least Physics II</td>
<td>23</td>
<td>5.0</td>
<td>4.8</td>
<td>2.7</td>
</tr>
</tbody>
</table>

In Group 3 the less-than-perfect score for acceleration was due almost entirely to the inclusion in this group of students having only Physics II in their degree.

While physicists and some teachers may see these results as surprisingly poor, they are quite consistent with those commonly encountered by others investigating the nature of students' misconceptions in physics e.g. Trowbridge and McDermott (1981). A point of concern is that these misconceptions are here evidenced in persons who are soon to be teaching children in the very same areas in which the misconceptions are so obvious.

It is clear that the major difficulty experienced by students undertaking this test is with the concept of acceleration and further analysis of students' responses concerning acceleration revealed the existence of common errors. These are shown in Figure 1 together with the percentage of students making the particular response.

While the above results have not been tested for significance it can be seen that a large proportion of graduates are committed to the belief that if an object is instantaneously at rest then its acceleration must be zero and further, that if there is a change in the direction of motion then there must be an accompanying sudden change in acceleration. While there has been no further probing in this study to determine the processes by which the students reached their conclusions, clinical interviews conducted with a group of undergraduates, having the same misconceptions, have shown that when dealing with the projectile problem, students typically revert to intuitive understandings rather than analysis based upon the application of basic kinematics. Thus it is common to find students justifying graph (a) on the basis that "well, acceleration means speeding up; if a thing has no speed it can't be accelerating, can it?"

Hewson and Hewson (1983) in an empirical study involving ninety secondary school science students (average age 16 years) found significant gains in learning by using teaching strategies based upon recognition of students' concepts prior to instruction. Ausubel (1970) cited Preece, (1984) maintains that in order to produce meaningful learning the instructor must initially recognise and change the learners' misconceptions.

![Graphs](image)

**Figure 1.** Showing the most popular incorrect responses for acceleration/time. Percentage of students making the response is shown.

If the importance of dealing with a learner's misconceptions is accepted, then it would appear that physics educators are faced with the challenge of producing teachers who are not only conscious of the existence of pupils' alternative conceptual frameworks but who do not themselves revert to intuitive concepts when faced with the need to explain phenomena involving basic kinematics. One apparent way of doing this is to encourage more appropriately qualified physics graduates to enter the teaching profession. At the same time it will be necessary to recognise that since a number of science teachers will teach physics out of necessity rather than as a first choice, then their misconceptions should be tackled during their brief exposure to tertiary physics.

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Board of Senior Schools Studies, Examination Statistics.


The Australian Physicist, Vol. 24, 1987-Page 119
Where Have All the Physics Teachers Gone?

Cliffon L. Smith,
Department of Science
Western Australian College of Advanced Education

Introduction

Like most industrialised countries, Australia has an increasing shortage of physics teachers, which if the trend continues will lead to a drastic lowering of overall standards in the teaching of physics. An interesting article by Brian Davies, who is the Policy Support Officer of the The Institute of Physics, was recently published in the Physics Bulletin (38:56, 1987) with recommendations to arrest the shortage of teachers of physics in Britain. This article has reported the findings of the British Department of Education and Science, in what can be described as a well written and succinct consultative document entitled "Action on Teacher Supply in Mathematics, Physics and Technology". The British Department of Education report described the gathering and analysis of data on the numbers of physics teachers entering and leaving the profession, in the context of the present and future needs of secondary schools in Britain. These British data clearly show that the secondary schools are faced with "an acute, chronic and worsening shortage of physics teachers". The Institute of Physics Response to this consultative document of the Department of Education and Science has been presented in an abbreviated form in the Physics Bulletin article. I have given the major argument of this Institute of Physics Response, and have included relevant comment from a Western Australian perspective of the issues raised.

The Institute of Physics Response

The Institute of Physics has presented eight recommendations for action to redress the current situation in declining physics teacher availability in Britain. The recommendations relate primarily to the important need for recognising the professional standing of teachers of physics and technology, and the necessity of providing much needed support services in the schools. The Institute of Physics is aware that head teachers and others responsible for the allocation of resources in the education system require a better understanding of the needs of teachers in laboratory-based subjects. The demands placed on the physics teaching in times of constantly changing curricula are enormous, and contribute to losses from the profession.

Recommendation 1: During their one-year [teacher] training period teachers should be paid a full year's basic salary. The payment would act as a mark of recognition of the importance of the profession, and as an incentive for recruitment. It has been observed that the British Government's Bursary Scheme may have been the reason for the 5% increase in applications for physics teacher training places this year.

The current Australian context for this issue places the financial responsibility for tertiary undergraduates upon the individuals. A means-tested Austudy scheme is available, with financial assistance at a subsistence level. A major policy change by Federal and State governments would be needed to reverse the present situation.

Recommendation 2: Conversion courses should:

(i) meet minimum criteria agreed by professional bodies, and
(ii) lead to a recognised, and career-enhancing qualification.

The deficiency in the number of physics teachers can be rectified by suitable and appropriate conversion courses for people from industry. Retraining programmes should be encouraged as a means of fulfilling a need in the education sector. However, the conversion qualifications must be recognised by education employing bodies so that career expectations can be realised.

To my knowledge, no serious attempt has been made in any of the Australian States to initiate physics teacher education programmes through conversion courses. However, provided the appropriate "end-point" qualification is achieved, this recommendation should be supported by educational employing agencies.

Recommendation 3: Funds should be made available immediately to enable school physics departments to replace and upgrade equipment, and to appoint technician staff, so that teachers can meet the requirements of modern syllabuses.

Poor conditions of service and inadequate technical support have been blamed as reasons for the current high resignation rate of 640 physics teachers per year in Britain. An immediate provision of funds is needed to upgrade and replace physics teaching equipment. The Institute of Physics recommends that the Department of Education of Science should take a lead in determining the minimum requirements of school physics departments, to enable them to set up, operate and maintain their laboratory work at the levels necessary for modern syllabuses.

A lack of laboratory work activity in secondary school physics appears to be evident in Western Australian (and Australian?) schools. Although the W.A. Tertiary Entrance Examination Physics syllabus requires specific laboratory skills to be mastered and that an adequate amount of laboratory work be completed, this requirement is not entirely being met. The enthusiasm for the practical application of physics through extra-curricula activities such as camera clubs, electronics interest-groups, and astronomy clubs functioning out of school hours is a relic of a past era in physics education.

The requirement of well-equipped laboratories, a preparedness of physics teachers to make physics more laboratory-centred, and the availability of technically competent assistants would encourage the able physics teachers to remain in the profession, and will also attract others to join.

Recommendation 4: Heads of physics should have adequate secretarial help, and their management roles should be properly recognised by sending them on management training courses.

The availability of secretarial assistance probably depends upon school policy or the educational system in which the physics teacher is employed. However, the issue of the acquisition of managerial skills has commonality with most science-based professions (for example, engineers, chemists and pharmacists) where promotion requires the effective and efficient management of people. Australia, like Britain, expects these important skills to be gained "on-the-job" with little or no attempt by Departments of Education to require or encourage individuals to attend appropriate post-graduate programmes of study.

Recommendation 5: The return of qualified women physicists to teaching should be assisted by the provision of child-care facilities, flexible time-table arrangements and part-time work.

Qualified women physicists are a group of potential teachers of physics and technology in secondary schools. However, recognition of the problems encountered by women re-entering the work force needs to be addressed. Refresher courses in physics must be provided, while existing teacher education programmes are probably satisfactory for present requirements.

Greater flexibility in employment conditions could assist the entry of women into physics teaching. The provision of child-care facilities by education authorities or local
government, and fractional employment within adaptable time-tabling arrangements are among a number of actions possible.

Recommendation 6: The government should provide incentives to industrial companies to become more seriously involved with schools in industry-education initiatives. This can be achieved through better understanding by their colleagues in industry of the roles and the skills of physics teachers. The Institute of Physics proposes tax incentives for industrial companies to take physics teachers onto their staff for paid work during the summer vacations. Such an initiative would promote industry-education awareness, and also would serve to increase teachers' salaries. It has also been proposed in Britain that experienced teachers should be encouraged to attend staff meetings of companies, to explain the needs of local schools, and to propose (and initiate) industry-education schemes, and industry-orientated curricula components.

This recommendation has much to commend in the Australian context, where an industrial awareness is becoming increasingly important for universities. Greater relevance and application of physics at secondary school will be necessary for the technology-led recovery of Australia. The future students of physics in this country will require the present teachers of physics to acquire greater experience in industrial application.

Recommendation 7: The D.E.S. should give careful consideration to the effects of introducing combined or integrated science at a time when there is a shortage of physics teachers. Current curriculum reforms are not opposed by the Institute of Physics in Britain. But the Institute makes the observation that very able young physicists may not find the prospect of teaching science, as opposed to physics, very appealing.

In general, in Australian education systems there is the expectation that science teachers instruct integrated courses, or at least specialise in groupings of science such as physics and chemistry. Only in exceptional circumstances could a teacher specialise in physics alone. However, potential science teachers are well aware of this employment requirement, and so can not express disappointment when physics teaching is not as prevalent as desired. Perhaps it is this requirement of educational employing agencies that discourages the more able physics students from pursuing a career in physics teaching.

Recommendation 8: The D.E.S. should spearhead a campaign to make the public more aware of the importance of physics for our future, and of how vital is the role of the secondary school teacher.

The Institute of Physics argues that a profession where morale is high will attract good graduates. However, in Britain both the image and the reality of the physics teacher's role need to be improved. It is a great deal for the country to get the physicists it needs in the coming decade.

This recommendation is directly applicable to the Australian scene, where both physics and science teaching in secondary schools need promoting to improve their status. The Australian Institute of Physics recognises this deficiency in appeal of physics by potential students. Perhaps consideration could be given to a media campaign to promote physics by the Australian Institute of Physics.

Several concluding comments can be made with respect to the teaching of physics in Australia. Firstly, the quality of the people becoming physics teachers (and science teachers in general) has deteriorated over the last two decades, with resultant decline in ability, skills and general effectiveness. To redress this situation it will be necessary to attract capable physicists to the teaching profession either through enhanced work satisfaction, salary differentials, or a system of rewards for services rendered.

The second comment deals with the entry of physicists from industry and the public service into the teaching profession. It is now acknowledged that several career changes will occur in the lifetime of an individual. Departments of Education throughout Australia should encourage career changes and offer attractive conditions for transfer for able people. For example, the physicist from industry (or the astronomer from an observatory) should not have to commence a teaching career at the bottom of the salary scale with new graduates. Attractive salary arrangements, and promotional opportunities, should be organised to serve these people.

Finally, although physics should be taught by physicists, it must be remembered that teachers teach people. The teaching of physics at the secondary high school level is a difficult and demanding task, which is not always recognised as such by academic and private sector physicists. Not only do we require correct physics to be taught, but we need stimulating physics lessons to be presented. The classroom managerial skills may be as important as the physics being taught.

Conclusion

The problem of the decline in physics as a desirable and acceptable discipline for study in secondary schools has been recognised by the appropriate national educational bodies in many countries. The Institute of Physics in Britain has begun to address this problem in their submission of recommendations to the Department of Education and Science.

The time is now appropriate for the Australian Institute of Physics to similarly address this problem of the decline of physics. The formulation of A.I.P. policies is needed so that strong and achievable recommendations can be made to the appropriate Federal and State Departments of Education. If the recovery of Australia's economy is to be achieved through a technological endeavour, then the education of physics at secondary and tertiary levels should be placed high in the priorities for immediate attention.

Computerised Information Service for Britain's Schools

An easy-access computerised information service for schools has been launched in Britain. The National Educational Resources Information Service (NERIS) is linked to the Open University's computer. It presents information about education in a standard format with an easy to understand system needing no detailed computer knowledge.

By using their own school microcomputer and modem - the device that links computers to databases via telephone lines - teachers can dial into NERIS and obtain information about teaching aids for classroom use. Details of resource packs, workshops, videos, computer programs and audio-visual packages are all available.

More than 130 organisations have already offered material to NERIS, which so far contains 3,000 data inputs. This is expected to expand to 50,000 in a year.

The aim of the system is to provide a single database of information about teaching and learning materials that are currently scattered around Britain. At first there will be a bias towards the sciences and to the secondary phase of education, but this is likely to change rapidly as the database grows.

Initially, materials contained in the database will be limited to text, but graphics and data held in ASCII code will be available for downloading as the development proceeds.

The £80,000 NERIS project is being funded by Britain's Department of Trade and Industry until April of next year. After that it will move towards being self-financing.

Each of Britain's 36,500 schools has at least one microcomputer, and last year the government announced it would supply modems, so that every secondary school would have immediate access to several education databases, with other schools to receive the same facility later.
NEW PRODUCTS

ETP OXFORD

Radiography Survey Meter

Dosimeter Corporation Model 3009 is designed for both medical, educational and industrial radiography use.

Model 3009 has an internal detector eliminating loose probes. The detector is a compensated G.M. Tube with preset high voltage supply. A circular meter gives the readout and an audio headset is an option.

The Radiography Survey Meter measures Gamma and X-rays over the range 80 Kev to 1.25 Mev. Accuracy is ±/−20% and the SI units model is calibrated in mSv/hr. It has 3 ranges and is extremely simple to use.

Bertan Releases New GPIB Programmable H.V. Supplies

Bertan Associates of New York, U.S.A. has, since 1969, been dedicated to the design, development and production of Precision High Voltage Power Supplies. Bertan's already extensive line of High Voltage Supplies is now extended by the addition of the new Series 225. These supplies bring together Bertan's wide experience in producing precision high voltage supplies and the accuracy of digital control.

Series 225 is ideal for laboratory use or for including in systems. It has a 5-digit display with flag annunciators to indicate the parameter being measured (volts or mA). Other flags indicate operation of the IEEE-488 bus and indicate overload or trip conditions at a glance.

Silicon Products from Thorn EMI

The range of Silicon products from Thorn EMI Electron Tubes, includes Silicon Avalanche Photodiodes. The avalanche photodiode consists of a silicon P-N junction which is operated at reverse bias close to that required for avalanche breakdown. The special characteristic of avalanche photodiodes is that the internal current gain is obtained from the multiplication of photo-generated carriers. Signal multiplications in excess of 100 times are achieved, to raise weak signals above the amplifier noise.

Photovoltaic Diodes and Arrays are made by diffusing boron into N-type silicon. They are designed for operation at zero external bias and give a response in the range 200-1100nm. Maximum quantum efficiency is 60% over the wavelength range 600-950nm. Various element sizes can be produced, from about 1mm2 single diodes to large 50mm x 50mm arrays to any required configuration.

For further information contact:
Fred W. Blake,
ETP Oxford Pty Ltd,
31 Hope Street,
ERINGTON, NSW, 2115.

Phone: (02) 858 5122

QUENTRON OPTICS

Two New Computer-Controlled (CCNIM) Counters

The Model 994 DUAL COUNTER and TIMER and the Model 995 DUAL COUNTER are the newest additions to the rapidly expanding CCNIM™ (Computer-Controlled NIM) product line introduced by EG&G ORTEC. Both offer exceptional configuration flexibility and the incomparable power of the EG&G ORTEC CCNIM connection.

The 994 gives your computer all the usual counting controls and contents readouts that you would expect plus:
- Setting and reading preset values.
- Selecting and setting time base.
- Disabling front panel controls.
- Reading the overflow status for both counters.

The 994 offers the choice of IEEE-488, RS-232-C, or standard print loop, as well as four modes of operation:
- Dual counter and blind timer.
- Counter and displayed (preset) timer.
- Preset counter and displayed time.
- Preset live timer and counters.

Collimated Laser Diodes

The GALA laser system is a new series of collimated laser diodes from D.O. Industries, Inc., that can replace HeNe lasers in many applications at substantially reduced cost. The compact, stand alone devices are GaAlAs lasers with output power levels from 4 to 25 mW and wavelengths from 750 to 830 nm. A variety of output beam diameters is available.

Applications include: alignment systems, optical instrumentation, laser doppler velocimetry, education, communications and general laboratory use.

Infrared Viewers

Electrophysics Corp. announce the release of two new products for near-IR imaging. The model 7215 Electroroviewer is a compact, battery-powered, handheld device with useful sensitivity extending to 1200 nm. This low-cost device may be used to observe radiation emitted from laser diodes, Nd:YAG lasers and other near-IR sources. The Model 7290 Microviewer is a high-resolusion, high sensitivity TV camera employing a 25mm vidicon with a PbO-PbS photoconductive target. Useful sensitivity extends to 1800 nm. The instrument provides a video output for connection to a TV monitor or video recorder. The instrument is extremely useful for the detection of mode patterns and measurement of power output from near IR laser sources such as GaAs, Nd:YAG and HeNe (1150 nm). Other applications include the detection of objects above 250ºC, photographic darkroom monitoring and active surveillance.

Laser and Optics Catalog

Newport Corporation announce the release of their latest catalog of precision laser and optics products. The 400 page volume includes many new products and covers optical tables and breadboards, micropositioning and mounting hardware, sources and detectors, lasers, optical and fibre-optic components, electro-optic instruments, holographic systems and machine vision products. In addition, the catalog contains valuable tutorial material and application notes.

For further information on Quentron products and your complimentary copy of the Newport catalog please contact:

Mr Simon Miles or
Mr Paul Wardill at
Quentron Optics Pty. Limited
G.P.O. Box 2212
ADELAIDE S.A. 5001
Telephone: (08) 223 6224
Telex: QTRON AB25809 Facsimile: (08) 223 5289

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A.C.T.

Solar Flares

For its first meeting of 1987, on 18 February, the A.C.T. Branch had the pleasure of hearing Prof D.B. Melrose describe some recent developments in the study of solar flares.

Solar flares involve explosive release of energy in the solar corona, primarily as high energy electrons which produce a variety of secondary effects, notably hard X-ray bursts. The flares have been recognised since 1859 but until 1926 were studied only indirectly, mainly through their effects on the terrestrial field and ionosphere. In 1926 Hale's invention of the spectrograph permitted direct observation by restricting the window to the Hα line of hydrogen. In the latest decade or so there has been a great increase in observational data, largely through spacecraft observations, and this has led to interesting advances, not just in solar studies but in our understanding of some aspects of basic physics.

Magnetograph observations provide most of our data on the structure of the magnetic field above the photosphere, which is the sun's visible, granular surface, but only within the lower part of the overlying chromosphere. The field is quite transient and emerges from below the photosphere through small, "active" regions called pores, which may persist during several solar rotations, i.e., several months. Several pores may coalesce to form a sunspot and it is in such actively developing regions that solar flares seem most likely to occur.

The magnetic field strength emerging from them reaches 0.2 T, far stronger than the mean solar field of 10\(^{-4}\) T, and is independent of pore size. Deduction from this magnetic data has established that observed pore motion must reflect gas motions originating deep within the photosphere. Vector magnetographs permit determination of the electric current flowing along the magnetic field lines. It turns out to be several times 10\(^{4}\) A which is near the maximum possible value consistent with the existence of electric current propagation.

Overlying the chromosphere is the solar corona, where a sharp temperature rise occurs from less than 6 x 10\(^{4}\) K in the chromosphere to more than 10\(^{6}\) K. The sudden rise results from reduced power radiation capability of ionized gas in this temperature range, resulting in heat build-up which must be dissipated through conduction at a region of sharp temperature gradient. High in the corona hot gas can cool to chromospheric temperatures, producing "coronal condensations" where heating has been impeded by local magnetic structure. Against the sun's disc these are dark "filaments" but silhouetted against the blackness of surrounding space they are bright "prominences". A prominence "erupts" when the cool material in the condensation is ejected from the solar atmosphere in a spectacular explosion. This is not a solar flare and the relation between them is both uncertain and controversial. Some 40% of solar flares do not have associated filaments or prominences.

A solar flare can be divided into three phases. The first and third comprise a gradual rise and fall of energy release over an hour or so, interrupted by the central phase confined to a few minutes of highly impulsive bursts of energy ranging across the spectrum from radio to γ-ray frequencies with periods as short as 0.1 s, the lower limit of resolution. Their intensity varies rapidly with time, the variations highly correlated across the spectrum. This activity emanates from a localised flux tube, in which the temperature rises to several times 10\(^{7}\) K, as well as from the footpoint of the tube in the chromosphere.

It is accepted that the only possible source of the energy released in a flare is the dissipation of electric currents in the corona. Dr Melrose described an electric circuit model which he prefers for explanation of solar flare behaviour. In this model the energy release is attributed to ohmic-like dissipation of electric current flowing through the corona against resistance. There are constraints, however, which lead to the failure of the model because the resistance value it requires is significantly too low to account for the actual energy release. It would appear that the model's requirement for interparticle collision effects in a thermal plasma are inadequate. Dr. Melrose concludes that the dissipation process must be collisionless. He is currently exploring possibilities in this direction.

In discussion of some of the theoriesfavoured to explain this phenomenon, he described their basis and identified their apparent failure to meet various particular boundary conditions. In general, however, he acknowledged that present technology cannot extrapolate the critical small-scale laboratory experiments with any confidence that they represent the reality which exists in the relative vastness of the solar flares. Theories of anomalously high resistivities and localised "double layers" of potential drop cannot be realistically tested. They are at the forefront of current research into processes of collisionless plasmas. Dr. Melrose expressed the hope that continued solar flare research may prove rewarding in itself but may also lead to a wider understanding of collisionless plasma processes generally.

N.S.W.

In the April Meeting, Dr Michael Gore, Director of the National Science and Technology Centre, informed, entertained and generally enthralled an audience in excess of 250, made up of members of the Institute and teachers and students.

He described how the construction of the National Science and Technology Centre marked the culmination of nine years of effort to promote science in Australia, and how the success of the first hands-on science centre, Questacon, was directly responsible for securing government support for the Centre. Whereas the headquarters building will be in Canberra, the NSTC will have a number of external programs that will be seen by people all over the country. A travelling science exhibition, called the Questacon Science Circus, has been extremely popular, and Dr Gore performed a number of demonstrations from the circus.

They all vividly demonstrated physics in real life and they all worked to the delight of the students present. If the response of this audience was any guide, Dr Gore (and his explainers) have been very successful in promoting science.

We should all be grateful! - Brian Window

Emission, Absorption and Dispersion of Gyromagnetic Waves

P. A. Robinson, Department of Theoretical Physics, University of Sydney.

PhD Degree awarded January 1987.

Part I is concerned with obtaining analytic expressions of wide validity for gyromagnetic emission and absorption by relativistic and mildly relativistic plasmas of various degrees of anisotropy. These expressions are used to investigate the polarization of the emission and the possibility of gyrosynchrotron instability. Suppression of cyclotron instabilities due to overlap between the cyclotron harmonics is also investigated.

Part II considers weakly relativistic effects on the dispersion of electron cyclotron waves. Initially, the theory of relativistic plasma dispersion functions is reviewed and extended to...
provide the necessary mathematical basis. Later chapters are concerned with weakly relativistic effects on waves propagating parallel or perpendicular to an ambient magnetic field, in particular near the cyclotron frequency and its second harmonic. Finally, weakly relativistic effects on electron Bernstein waves are considered in detail. These effects are found to eliminate most of the previously predicted weakly damped Bernstein modes due to resonance broadening and cyclotron damping.

This thesis is based on the following publications:


S.A.

An Underwater Diver Acoustic Navigation and Surveying System
K. Scott, Masters in Applied Physics Student, South Australian Institute of Technology.

The project is entitled "An Underwater Diver Acoustic Navigation and Surveying System" and involves the development of a short range (≤200 m) and shallow water (≤40 m) diver ultrasound and surveying system operating at a frequency of 150 kHz. Unlike other acoustic systems, which use 3 transponders, only one site transponder is used and so the working time of divers involved in the mapping of coastal salvage, engineering and archeological sites can be greatly reduced, with a subsequent increase in diver safety.

With the advent of the self-contained underwater breathing apparatus (SCUBA) in the 1940's, underwater measurements and observations have become more precise. These surveys, however, are limited to relatively small areas for the following reasons:

1. Good visibility is required to operate most devices.
2. The necessity to fix points relative to the shore.
3. Most techniques are labour-intensive and, thus, expensive.
4. Time spent by divers in making surveys is lengthy.
5. The need for triangulation in most techniques.
6. Inadequate diver-to-diver communication facilities.

It is envisaged that some of these problems can be eliminated by the use of the following system.

An omnidirectional (with some vertical directivity of about ±80º) transducer is used by the diver for both transmission and reception. At the centre of the site being mapped is a transponder which has a directional transducer that rotates in a horizontal plane about its vertical axis. Over the short range that the system is intended to operate, it is assumed that there is no horizontal temperature variation.

System Arrangement
The completed system will operate in the following manner:

1. The diver (B), who is mapping a site and wants his present location to be recorded, transmits a short 150 kHz acoustic signal for approximately 5 secs, which is received by the rotating transducer (C).
2. The transponder (A) then computes the diver's direction by analysing the received field strength of the diver's transmission using a microprocessor controlled receiver incorporating an analog to digital converter.
3. The next time the rotating transducer (C) is pointing in the direction which gave the maximum signal, it is stopped by the transponder (A), and this aligns the transducers.
4. The transponder (A) transmits sequential coded information to the diver's instrumentation using a synchronising frequency shift keying (F.S.K.) format.

This information includes the water temperature at the transponder and the diver's angular location relative to the transponder, accurate to approximately ±0.5º. The water temperatures at the diver's position and at the transponder are used to select an appropriate clock frequency to be used in the diver's receiving system. This selection procedure ensures the best accuracy in subsequently measuring the acoustic signal travel time (and hence distance) between the transponder and the diver. In particular, these measurements enable the system to calculate the speed of sound in the region between the transponder and the diver from the following equation:

\[ C = 1410 + 4.21 \times 10^{-3} T^2 - 1.14 S + 0.18 D \]

for \( 6^\circ C \leq T \leq 17^\circ C \)

where:

- \( C \) = speed of sound in m/s
- \( T \) = temperature in °C
- \( S \) = salinity in parts per thousand, and
- \( D \) = depth in m.

5. The diver's transducer (E) transmits a digitally-coded signal to the transponder to prepare it for the distance determining measurements followed by a pulsed signal and after an accurately known time delay, the transponder transmits a similar pulsed signal back to the diver.
6. The diver's instrumentation computes the distance.
between the diver and the transponder from the time taken for the transmission and reception of the pulsed signals, giving due regard to the time delay at the transponder (A). The expected accuracy from this measurement is \( \pm 0.1 \) m.

7. The diver now transmits a coded signal instructing the transponder (A) to recommence rotating and to record the next set of measurements.

In field experiments that have been conducted so far, the adequacy of water tight seals used on the transponder and the logistics of assembling and launching a raft that was specifically constructed for such field work were tested. Also the acoustic field patterns radiated by the transponder were recorded over a transmission distance of approximately 250 m in fresh water at Thornton Park Aquatic Reserve in very unfavourable conditions.

Our next field trip, which we hope will be carried out in laboratory-type conditions, i.e., flat surface, no wind, etc., will be for the transponder to detect the direction of the maximum signal and stop its rotating transducer when it is pointing in that direction. We also intend to send the stored bearing measurement to the diver's transducer and to display the result.

Physicists as Engineers
B.H. Candy, Ph.D. Student, The University of Adelaide.

Politics Politicians, businessmen and journalists have recently emphasized that to maintain its material standard of living, Australia needs significantly to replace its shrinking traditional export markets based on materials derived from the earth (agriculture and mining) with knowledge-based products, such as "hi-tech". Under current financial constraints, it is clear that those groups who are perceived to enhance the economy will receive relatively higher government funding. At present, physicists are not seen as one of these groups. However, this perception is based on tradition and not on the potential of physicists, who I believe have more appropriate training for the development of state-of-the-art technology than engineers.

My background I have worked in the electronics industry for over ten years, six of which have been full-time in four different countries. In October 1985, another physicist, two businessmen and I founded a "high-tech" public company which has been financially successful, particularly in attracting attention overseas.

State-of-the-art technology To be more proficient than other competitive R and D companies it is usually necessary to design better products. This is particularly so in Australia where the local market is small, the cost of labour and freight high, and where it is difficult to obtain large orders of components at short notice without incurring great expense. These factors combine to make Australian products less attractive to overseas distributors.

I believe my company's product sells well because it significantly outperforms its competitors. The improved design results from a thorough consideration of the fundamental aspects of the problem; a modus operandi for which I think physicists are particularly well trained. State-of-the-art technology usually incorporates newly found concepts which most often follow from meticulous consideration of the fundamental aspects of the problem.

The Role of Physics and Engineering I shall now attempt to present a simplistic comparison of the practices of engineers and physicists:

Engineering Engineering is concerned with the application of science to create artifacts, some sort of "end manufacturable product", or mathematics or concepts to facilitate the design of these "end products". In practice most engineering design involves creating new products by different arrangements of building blocks and concepts that are well defined and "understood", often in a simplistic way. Furthermore, most engineers appear to regard mathematics as a set of useful equations rather than a system of logic from which other equations can be deduced. This method of design is known as the "cook-book approach". For most engineering tasks the "cook-book" method is all that is required, and is indeed time-efficient. I think physicists should defer to this niche and recognize that such an approach is often essential in industry, where there is sometimes considerable pressure to complete tasks quickly. The "cook-book" approach is thus most expedient.

However, my observations are that too much of this type of engineering occurs in tackling "state-of-the-art" projects where a more tailor-made strategy would be far more appropriate.

Physics Physics is a discipline which endeavours to formulate fundamental laws of nature. Here the "end product" is an "understanding", often initially perceived as aesthetic. An example is cosmology. But what a wonderful aesthetic! I have yet to meet a person who has not shown some delight in some of the findings of the cosmologists. I certainly hope they can be put to practical use or at least put on a practical basis. Thus, unlike engineers most physicists are fascinated mainly by concepts, often not manifest in some easily accessible form. Graduating physicists, therefore, have to practice at coming to terms with very fundamental concepts, and cannot jump into the "deep-end" with well-behaved prefabricated "black-boxes" as engineers can and certainly do. It should be remembered that many concepts in engineering do originate from physics.

Conclusion It is my experience that physicists are more likely to produce original solutions to "state-of-the-art" problems where a sound understanding of the fundamental background and inventiveness are required. We physicists should earnestly lobby businessmen and politicians to use physicists more for high-tech purposes.

A Technique for High Speed Analog Tomography
A. Garvie, Ph.D. Student, The Flinders University of South Australia

In both fundamental and applied physics it would often be beneficial to be able to determine the spatial distribution of a variable within an object. The solution to the problem of constructing an image of a two-dimensional section of a three-dimensional object has been known for several decades. The analytical solution was first published by Radon [1917] and involves the Radon transform and inverse transform.

However, it was the rediscovery of the technique by Bracewell and Riddle [1967] that produced an experimental implementation. Since then a variety of algorithms including two dimensional Fourier reconstruction, iterative reconstruction and filtered back-projection reconstruction have been used in tomographic imaging [Brooks and Di Chiro, 1976]. Of these, the filtered back-projection technique has proved to have a number of advantages and as a result it has become the most popular.

The Radon transform,

$$ f(\theta) = \int f(x, y) \, dx $$

is the projection, or line integral, of a function \( f \) along all possible parallel lines in a particular plane of the object (see figure 1). Although \( f(x, y) \) is often the x-ray attenuation coefficient at the point \( (x, y) \) in the plane of interest, the

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photographic film for a two-dimensional CCD integrating array would allow real-time imaging of dynamic systems. The apparatus would then be robust, low in cost and high in speed, hence lending itself to applications where portability is required. Figure 2, a transverse section of a kangaroo skull, is an example of an x-ray transmission tomogram produced by integrating on photographic film.

![Figure 2](image-url)  
**Figure 2.** A transverse section through a kangaroo skull produced using an analog tomography processor.

### References


### W.A.

**Summary of March Meeting of the WA Branch of the AIP**

The first meeting of the WA Branch for 1987 was held at Murdoch University on Wednesday the 4th March, 1987. An enthusiastic group was addressed by Dr. Robyn Owens from the Computer Science Department of the University of Western Australia. Dr. Owens's seminar on, "Feature detection using local energy" covered her recent work on the detection and recognition of objects from a digitized video signal, undertaken in conjunction with the Visual Laboratory of the UWA Department of Psychology.  

Her talk concentrated specifically on the detection of edges and shadows on images, which is considered to be essential in the first stage of object recognition. Her review of the "Marr-Hildreth" and "Canny" techniques illustrated their limitations which included susceptibility to noise, poor representation of the edges produced by shadows and lengthy digital processing.
times. Using several graphic slides Dr. Owens demonstrated the importance of ‘Mach bands’ in the perception of shading by human vision and indicated that this was essentially the feature which the earlier techniques had failed to consider.

The approach taken by the UWA visual research group, to integrate this factor into digital image manipulation, was through the use of Fourier theory. By applying Hilbert transforms to the digitized image data an energy or amplitude argument can be extracted to produce a truer ‘image to object model’. The method described by Dr. Owens also had the added flexibility of discriminating between the ‘step,’ ‘delta’ and ‘trapezoidal’ components of images and also consumed much less CPU time than other techniques. Both of these features have significant application in robotics and other artificial vision systems. Several further slides of circles, printed type, and coffee cups were used to clearly demonstrate the advantages of this technique.

One of a number of interesting side issues raised during question time was the possible application of this theory to improving our understanding of the physiology of vision.

It was very encouraging to hear of such significant research in this demanding field taking place in Australia and the branch wishes to thank Dr. Owens for her enlightening insight into this fascinating subject.

Robert Loss

Physics Quiz Night

The W.A. Branch of the Australian Institute of Physics held its third annual Quiz Night on Tuesday, 24 August at Murdoch University. The event was very well attended, with 59 teams competing from some 40 schools around Perth. Each team had six members and generally one or two teachers accompanying them.

As with most other quiz nights there were two central objectives. The first was to find out which of the 59 teams from years 11 and 12 could correctly answer the most questions. The second was to ensure that the evening was enjoyed by all.

The competition to find which school had the best prepared students was keenly fought. Scotch College had won the last two quiz nights and so was eager to retain the honour. Questions for the night had been laboriously chosen by physicists at Sir Charles Gairdner Hospital, Royal Perth Hospital, Murdoch University and UWA. They varied in difficulty but were generally of a very high standard and demanded a very broad and good understanding of many areas in physics. The eventual winners were Duncraig Senior High School, with Christ Church College taking second place.

The organisers were delighted with the quality of the students’ responses to the questions. They reflected a broad interest in physics beyond the secondary syllabus and indicated a high level of preparation.

The more serious side of the evening was relieved by a series of light-hearted competitions. These included finding the most uses for a Cathode Ray Oscilloscope and a joke competition. One prize winner in the joke competition entered the following:

Question: "What is big and yellow and looks good on physicists?"
Answer: "A caterpillar tractor".

The organisers were able to overlook such entries and kept the teams in good spirits until the competitions were decided.

The enthusiasm of the teachers who organised their students, and of the students who attended, made the evening a great success. We can only hope that this enthusiasm will flow over into their more serious study of physics and that we will be guaranteed many more well-trained physicists to underwrite our high technology society.

Stephen Thurgate

Book Presentation

Presentation of the new book, "Introduction of the Equations of State", from Cambridge University Press by Shalom Eliezer, A.K. Ghatak and H. Hora at the University of New South Wales. Professor Eliezer is a Gordon Godfrey Visiting Professor in Theoretical Physics from the SOREQ Nuclear Research Center in Tel Aviv, Israel. Professor Ghatak worked at UNSW on an ARGS grant during 1983/84 and went to the Singapore National University. Professor H. Hora is Head of the Department of Theoretical Physics at UNSW.

The book was presented by Professor Sir Ernest Turner Ton from the Australian National University on 25th March, 1987 during an international meeting on "Volume Compression and Electric Double Layers in Laser Fusion", highlighting also that the book got an appraising foreword by Edward Teller, the pioneer in the physics and physical chemistry of high density matter and the equation of state. In the picture is Professor Sir Ernest Turner Ton with the book at his address with Professor Eliezer. On their right are Prof. Yu. V. Afanas'ev from the Lebedev Physical Institute of the USSR Academy of Sciences in Moscow and Prof. H. Hora. In the background is Emeritus Professor C.J. Milner, a friend of the late A/Prof. Gordon Godfrey who donated $400,000 for the advancement of Theoretical Physics at UNSW. To the left of Prof. Sir Ernest Turner Ton is Dr. George C. Baldwin from the Los Alamos National Laboratory in the USA and Dr. A.V. Rode from the Lebedev Institute in Moscow.

The retyped text of the address of Professor Sir Ernest Turner Ton in celebrating the book as well as his general remarks when closing the international meeting and further the welcoming address by Prof. J.C. Kelly as Chairman of the Faculty of Sciences are available from the Department of Theoretical Physics (Miss Kathy Miller, 4571).
Conferences and Meetings

1987

Jul 8-9  Technology and Exports, Brisbane.

Lee Rystrand, The Institute of Engineers, Australia, 11 National Circuit, Barton, ACT 2600

Jul 14-16  Automated Vision Technology, Caulfield East.

Dr C.F. Osborne, Applied Physics Dept, Chisholm 1 of T, 900 Dandenong Road, Caulfield East, VIC. 3145.

Jul 20-Aug 14  Radiosotope Course for Graduates, Lucas Heights.

The Principal, Australian School of Nuclear Technology, Locked Mail Bag No. 1, Menai, NSW 2234.


The Conference Manager, Information Technology Conference 1987, The Institute of Engineers, Australia, 11 National Circuit, Barton, ACT 2600.

Aug 3-8  International Symposium on Experimental Gravitational Physics, Guangzhou, China.

Dr D. Blair, Department of Physics, The University of W.A., Nedlands, W.A. 6009.

Aug 4-12  4th International Symposium on World Trends in Science and Technology Education, IOSTE, The Netherlands

J. van Trommel, P.O. Box 2061, 7500 CB Enschede, The Netherlands.

Aug 8-10  Neutron Scattering Symposium, Sydney.

The Secretary - ANBUG, CS-AINSE, Private Mail Bag, P.O., Sutherland, NSW 2232.

Aug 10-14  7th EPS General Conference, Helsinki.

EPS Secretariat, PO Box 69, CH-1213 Petit-Lancy 2, Switzerland.

Aug 12-30  XIV Int. Congress and General Assembly, UC, Perth.

Dr E.N. Maslen, Crystallography Centre, The University of W.A. Nedlands, WA 6009.


Dr J.H. O'Donnell, Department of Chemistry, University of Queensland, Brisbane, QLD 4067.

Aug 17-21  ICAME87 - International Conference on the Applications of the Mössbauer Effect.

ICAME87, Department of Physics, Monash University, Clayton, VIC 3168.


E.H. Nickel, Division of Minerals & Geochemistry, CSIRO, Private Bag, Wembley, WA 6014.


Dr S.W. Wilkins, CSIRO, Division of Chemical Physics, P.O. Box 160, Clayton, VIC 3168.


The Hon. Organising Secretary, ANZAAS Congress, James Cook University, Townsville, QLD 4811.


Dr J.H. O'Donnell, Chemistry Department, University of Queensland, Brisbane, QLD 4067.


Prof. J. Rose, 5 Margate Rd, Lytham St Annes, Lancs. FY8 3EG, U.K.


Conference Secretariat, The Institution of Electronic and Radio Engineers, 99 Gower Street, London WC1E 6AZ.

Sep 14-18  14th Int. Conf. on X-ray and Inner-Shell Processes, Paris.

Secretariat, X87-Pierre Lagarde, LURE, Bâtiment 209 d, Université Paris-Sud, 91405 ORSAY Cedex, France.


Sep 26-29  General Physics Meeting, Physical Society of Japan, Tohoku University.

Physical Society of Japan, Room 211, Kikai-Shinko Building, 3-5-8 Shibah-Koen, Minato-Ku, Tokyo 105, Japan.

Sep 30-Oct 3  Elementary Particles Meeting, Physical Society of Japan, Usunomiya University.

Physical Society of Japan, Room 211, Kikai-Shinko Building, 3-5-8 Shibah-Koen, Minato-Ku, Tokyo 105, Japan.

Oct 6-9  Int. Conf. on Electrical Machines and Drives, Adelaide.


Nov 12-13  Annual Conference of the Australian Acoustical Society, Hobart.

Mr S.E. Samuels, ARBB, PO Box 156 (Bag 4), Nunawading, VIC 3131.

Oct 14-17  ASPEN Physics Education Conference, Kuala Lumpur.

Secretary, Dept of Physics, Universiti Kebangsaan, Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

Nov 15-19  International Conference on Lasers, Xiamen, China.

Professor Deng Xi Ming, P.O. Box 8211, Shanghai, China.

Dec 6-9  12th Aust. Conf. on Optical Fibre Technology, Surfers Paradise.

Conference Secretary, IEEE, Unit 3, 2 New McLean Street, Edgecliff, NSW 2027.

Dec 7-11  10th Int. Conf. on Lasers & Applications, Lake Tahoe.

Lasers '87, P.O. Box 245, McLean Va 22101, U.S.A.


Dr B. Bibby, Physics Dept, Victoria University, Private Bag, Wellington, New Zealand.

1988


Dr S. Collocco, CSIRO Division of Applied Physics, PO Box 218, Lindfield, NSW 2070.
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