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President's Column

After two years and two discussion drafts, the government's attempt to formulate a strategy for science and technology has been officially abandoned. This decision highlights the widening gulf between science policy and technology policy that is developing now, following the Prime Minister's decision to divide the science and technology portfolios.

In the foreword to the revised Discussion Draft of the National Technology Strategy, which was only released by the Department of Science in July, it is reported that over 250 written submissions were received from ‘business, government, unions, researchers, educators, public interest groups and individuals’ following the distribution of more than 8,000 copies of the initial draft Strategy. It is also stated that respondents were virtually unanimous that some form of strategy was an urgently needed initiative. Many submissions pointed to the diversity and pervasiveness of issues related to science and technology. Respondents stressed the need for integration with other policy areas such as industry, education, trade, social welfare and employment and industrial relations. Indeed, this is perhaps the most fundamental conclusion to be reached from analysis of the comments received: that the only successful approach is one that considers all of these policy areas together in a coherent and co-ordinated way.

No one could pretend that achieving such an objective would be easy, but it would now appear that there is little chance that an integrated policy for science and technology will be attempted.

The evidence for Australia’s low level of industrially funded research and development is clear and undisputed, as is our poor performance as an exporter of technology-based products. Yet an international survey of more than 200 chief executives in Australia, the U.S., West Germany, Britain, Japan and Belgium by PA Technology has shown that Australian managers were the most ignorant of the commercial advantages to be gained from new technology and in general their attitudes were antipathetic towards it.

In the preface of its submission to the ASTEC review of Public Investment in R and D in Australia, the Department of Industry, Technology and Commerce, whilst recognising the need to achieve an appropriate balance between basic, strategic and tactical research, acknowledges that no attempt is made to address the questions involved in its submission. Nevertheless, I have the distinct impression that Senator Button favours the adoption of a ‘carrot and stick’ approach, with the carrot being offered to industry and the stick applied to the research community.

While the Minister for Science, Barry Jones, is to be congratulated for the significant improvement in the standing of his portfolio in this year’s budget allocation, there are no grounds for the scientific community to be complacent. There is a strong belief in government that the present level of public funding for basic research is appropriate to Australia’s resources and there seems little likelihood of it increasing.

However, it is not the prospect of inter-departmental rivalry between Science and Industry, Technology and Commerce that I regard as the most alarming situation for the future, but rather the policies being followed by the Department of Education. The shortage of appropriately trained physics teachers, the reduction in secondary physics teaching and the emphasis on a qualitative, descriptive presentation; the restrictions on the number of places in tertiary education; the pressure to reduce cost-graduate numbers; the ageing population of university physicists; these are all gloomy portents for the future of Australian physics.

Fred Smith
T.F. Smith

Editorial

The Nobel Prize this year emphasises to me the difficulty of defining physics and chemistry, and I think we are lucky that the Institutes of physics and chemistry do not regard themselves as rivals. Consider the demarcation disputes that could arise! In the case of Karle and Hauptman, their Chemistry Prize was awarded for mathematical techniques based on physical insight, which have been applied to chemical and physical problems. In Australia, anyway, there is a high level of cooperation between chemists and physicists.

The other interface, at which there is less cooperation, is between these two sciences and engineering; and again demarcation is difficult because engineering consists of the application of the sciences. At the research level, I find the distinction almost vanishes. The question arises as to which is the most appropriate training, the in-depth approach of physics and chemistry, or the broad-field approach of engineering?

I believe that for the majority, any of the educational approaches is adequate, since people are reasonably adaptable and can fill in gaps in their education. The different courses provide stimulation to different types of student. But the most specialised fields of research require in-depth studies, so that the student who has glimpsed the frontiers and has experienced a rigorous training is at an advantage. There are two reasons: he is more likely to appreciate where deficiencies in knowledge occur, and he is better equipped to resolve them.

Jim Graham

The Australian Physicist, Vol. 38, November 1985 — Page 277
A Telescope Belonging to Sir John Monash

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Late in 1984, Mrs Elizabeth Durre, the granddaughter of General Sir John Monash, asked Professor John Swan, then the Dean of Science at Monash University, about the telescope of the General at her home. The telescope was in poor condition and the Physics Department workshop was asked if it could be restored. It has now been restored by Ken Nuske of the workshop and the telescope is now in good condition and in full working order. The optical image is first class.

The photographs show the telescope after restoration. It was made by Watson and Sons, High Holborn, London and has the number 696 on the plate carrying the eyepiece. A few measurements are given to aid identification. It was made before SI units were established and approximate dimensions are given in Imperial and metric units. The body is made wholly of brass. The overall length of the barrel is 3 feet 6 inches, 1050 mm and its diameter of 3½ inches, 90 mm. The aperture of the objective lens is just under 3 inches. The sighting telescope when closed is 1½ inches, 290 mm; it has cross wires. From the base of the tripod to the mounting nut about which the telescope can turn in elevation is 1 foot 4 inches, 410 mm. The main telescope has three eyepieces, one astronomical, one solar with a dense blue glass and one terrestrial. The objective is a doublet. The focusing is by rack and pinion, and the elevation can be changed also by rack and pinion.

This portable telescope is part of a long tradition of fine workmanship (1). After the concentration on reflecting telescopes in the seventeenth century especially with the influence of Newton, the development of these reflectors was continued into the eighteenth century in Britain principally by James Short (1710-68) and William Herschel (1738-1822). Short was a professional optician who made reflecting telescopes. Herschel was a professional musician whose amateur skill as a telescope-maker was so great that his telescopes commanded high prices. They were bought largely by institutions not private individuals. The invention of the achromatic doublet lens in 1729 changed the structure of the small telescope. A single lens, say a double convex lens, gives a focusing effect due to the refraction at the curved surfaces but the refractive index of the glass is colour-dependent and the image formed by a single lens in white light is coloured. It was known that a telescope whose objective was a single lens would give a coloured image; the original telescope of Galileo had a single lens for its objective. The solution to this problem of an uncoloured image in a refractor telescope was found in 1729 by Chester Moor Hall, a barrister and amateur optician. He combined a concave lens of flint glass and a convex lens of crown glass. The two kinds of glass have different refractive indices and different dispersions. The two lenses can be so chosen that the colour in the image can be almost completely eliminated over the visible spectrum and the combination doublet in the objective remains a converging lens. The fact that Hall's doublet was indeed achromatic, or very nearly so, was established by John Dollond (1706-1761) who with his son Peter (1730-1820) used the doublets in new telescopes which became very popular. The naval battles of the eighteenth century and the Napoleonic wars created further demands for the hand-held telescopes known familiarly as spy-glasses; the more certain

identification of coloured signal flags is the advantage gained with a good achromatic telescope.

The smaller, portable reflecting telescopes had been mounted on tripods and the new achromatic refracting telescopes followed this design. A common size had the barrel about a yard long and an objective lens of 3 or 5 inches aperture. Mechanical improvements that were added were rack and pinion for focusing and for change of elevation, articulated Hooke joints and a sighting telescope (a finder). The instruments were designed to be efficient and elegant. The tripod legs could be jointed and the instruments were easily portable. A dew cap would protect the objective from night dews and the library or the terrace of an eighteenth century gentleman's residence would not have been considered complete without a telescope.

This telescope of John Monash is in this tradition. The firm of William Watson was started in London in 1837 (2) and the Australian firm under the name of Watson and Sons was started in Melbourne in 1888 by H.H. Baker who had represented the London firm at the Melbourne Centennial Exhibition in that year (3)(4). In Watson's booklet describing the firm's century of business in scientific instruments (5) is a print of the "Educational Telescope" and the outline fits very closely the telescope under investigation. The print has the date 1885 but shows neither the rack and pinion for varying the elevation nor the sighting telescope. In the catalogue of the Optical Convention of 1905 is the simple verbal description (6) of what is called the Century Telescope.
of Watson's firm; "Object glass 3 to 5 inches, 3 eyepieces, finder etc". However in the catalogue of the Optical Convention of 1912 is a much fuller verbal description (7) of Watson's Century telescope which fits Monash's telescope except for the phrase "the stand which carries the telescope is of mahogany". It seems likely that such a variation could be expected with differing production runs. This full description (7) contains the phrase "The object glass is of the Watson-Conrady series...". A.E. Conrady set up in business as a model maker in London towards the end of the nineteenth century (8). The firm of Watson and Son called on the mechanical skills of the small Conrady model factory. About 1902 Watson and Sons engaged him on a full-time basis as a scientific adviser and lens designer. Most of Conrady's work concerned microscope objectives but he also designed photographic lenses and telescope objectives. In 1917 he became the Professor of Optical Design in the Technical Optics Department of Imperial College, London. The Century telescope was manufactured by Broadhurst and Clarkson, Farrington Road, London for Watson's (9).

It seems therefore that the most likely identification of Sir John Monash's telescope is that it is a Century telescope designed by A.E. Conrady about 1900 and which followed the same style and used basically the same barrel of the Educational telescope of 1885. It was probably bought through the Melbourne firm of Watson and Sons. During the restoration it was noted that some of its old paint was khaki. This raised the thought that the telescope may have been accompanied the General on some of his manoeuvres or field campaigns, but this would have been very unlikely as it is clearly more clumsy and dangerous to use in the field than binoculars. There is no information about the telescope in John Monash's recent biography (10) nor could his biographer A.G. Serle add anything (11). About 1924 John Monash bought an 80 mm Zeiss telescope that is still housed in the Zeiss building at the old Melbourne Observatory (12). He joined the Astronomical Society of Victoria and was in touch with E.O. Hercus of the Natural Philosophy Department, Melbourne University; in 1925 he visited the Mt Stromlo Observatory, recently opened.

The restored telescope was formally handed back to Mrs Elizabeth Durre and her family at a small ceremony on Friday 22nd March, 1985. Mrs Durre has kindly allowed the telescope to be put on temporary display at Monash University.

Acknowledgements

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References

2. X-rays. (1938), W. Watson and Sons Ltd., Australia, New Zealand. Published on the occasion of the Jubilee of the founding of the firm of Watson in Australia in 1888 by Henry H. Baker, formerly of Watson and Sons in London. He was joined by his brother Frank L. Baker shortly afterwards. Information from Hugh Hammersley, Librarian, Australian Radiation Laboratory, Melbourne, 1984.

Century Telescope Specification. The object glass is of the finest quality and is of the Watson-Conrady series, type III. The most important factor in the whole telescope is the object glass and this series is much superior to ordinary qualities. The body is of brass, with dew cap and at the eyepiece end an extending tube actuated by a rack and pinion. A finder is provided and included with each instrument are three eyepieces, two for astronomical observations and one for terrestrial purposes. The formers are usually supplied to give a magnification of 25 and 40 diameters respectively per inch of aperture of the object glass. Thus the powers with the 3 inch telescope would ordinarily be 75 and 120 diameters, but any other practical magnification may be chosen. They are filled with dark-coloured glasses of different tints, mounted in brass caps to screw over the eyepiece for the purpose of examining the sun or other bright object. The day eyepiece has a magnification of 60 to 80 diameters according to the size of the object glass. All the above is enclosed in a strongly fitted protecting case suitable for travelling, with wrench for tightening bolts and pin for adjustments. The stand which carries the.

telescope is of mahogany. At the top of the tripod a metal head is fixed carrying a strong metal cradle on which the telescope is placed and is evenly balanced.


9. Information from J.H. Hartley, Parry Instruments, Harpenden, Herts, U.K.

People

Applied Maths
Amalgamation at UNSW

The former Departments of Applied Mathematics and of Theoretical and Applied Mechanics have recently been amalgamated, to form one of the largest applied mathematics departments in Australia. Important areas of specialization in the new Department of Applied Mathematics are fluid mechanics and oceanography, numerical analysis, optimization, and control theory. The head of the combined department is Professor Ian Sloan, who was recently appointed to a personal chair in mathematics, began his professional life as a physicist, and worked for many years in theoretical atomic and nuclear physics. Currently he works mainly in numerical analysis—drawing the profit, he says, from all that he learned as a physicist.

Posthumous book is ‘outstanding’

A book which makes an ‘outstanding contribution’ to a very difficult area of astrophysics has been published after the death of its author, former Senior Lecturer in the Department of Applied Mathematics, University of Sydney, Dr Chris Cannon. Dr Cannon died in August last year aged 39, but had finished the manuscript before his death.

The book, The Transfer of Spectral Line Radiation, deals with how radiation passes through the atmosphere of stars and how the radiation can be interpreted in terms of the structure of that atmosphere.

At its launch on Tuesday 24 October in the MacCallum Room Dr Chris Durrant, Senior Lecturer in the Department, reviewed the book, placing it in comparison with other texts in the area, and praised its outstanding contribution.

Others to speak at the launch were Dr Ron James, an undergraduate student with Dr Cannon; Professor Peter Wilson, his PhD supervisor; and Dr Lawrence Cram of the CSIRO National Measurement Laboratory, who spoke about Dr Cannon’s work in Paris in the 1970s.

Paul Wild Observatory

The Minister for Science, Mr Barry Jones, announced tonight that the central site for the $32 million Australia Telescope would be named after the recently-retired Chairman of the CSIRO, Dr Paul Wild, a pioneer in solar radioastronomy.

Speaking at a CSIRO dinner to farewell Dr Wild as Chairman at the Lakeside Hotel in Canberra, Mr Jones said the Observatory at Culgoora near Narrabri in the mid-north-west of NSW would be known as the ‘Paul Wild Observatory’.

‘This is a fitting tribute to Dr Wild’s significant contributions to world radioastronomy and to his promotion of Australian science and technology,’ Mr Jones said.

Dr Wild was instrumental in the establishment of Culgoora as the world’s leading solar radioastronomy observatory in the 1960s, and played a major role in obtaining Government backing for the Australia Telescope as a bicentennial project.

‘As Chief of the CSIRO Division of Radiophysics, he was responsible for the development of Interscan, the next-generation international aircraft landing system. The Paul Wild Observatory at Culgoora will house the central facilities of the Australia Telescope, which will give Australia a top-class telescope capable of contributing to scientific discovery well into the 21st century.’

Scheduled for completion in 1988, the Australia Telescope will comprise six 22-metre diameter antennas at Culgoora, one at Siding Spring, and the existing radiotelescope at Parkes.

When operating in conjunction with other antennas in Australia, it will simulate a giant telescope over 1500km in diameter, one of the most powerful radiotelescopes in the world. It will also enable Australia to take part in southern hemisphere observations using the ‘QUASSAT’ space antenna planned by the European Space Agency and NASA.

Nobel Prizes

Professor Herbert Hauptman and Professor Jerome Karle of the United States shared the 1985 Nobel chemistry prize, the Royal Swedish Academy of Sciences announced on October 16th.

They were honoured for their outstanding achievements in the development of direct methods for the determination of crystal structures.

Professor Hauptman (68) is a professor of biophysics at New York State University in Buffalo.

Professor Karle (67) is director of research at the laboratory for the structure of matter at the U.S. Naval Laboratory in Washington.

Professor Klaus von Klitzing (42), of West Germany’s Max Planck Institute for solid-state research, won the physics prize.

Physics review

The Vice-Chancellor of the Australian National University has established a committee to review the Department of Solid State Physics, Research School of Physical Sciences, following relinquishment of its Headship by Professor W.A. Runciman.
Are We Just Filling In Holes?

by Dr. Kenneth G.H. Baldwin

a report on the meeting of Nobel Prize Winners in Physics at Lindau, W. Germany, 1-5 July 1985.

THE AUTHOR

Dr. Kenneth G.H. Baldwin is an A.N.U. Postdoctoral Fellow working in the Atomic and Molecular Physics Laboratory at the Research School of Physical Sciences. He graduated in physics at A.N.U. in 1977, and completed an M.Sc. with the Laser Group at R.S. Phys. S. He was awarded the 1979 Rutherford Scholarship by the Royal Society, and moved to Imperial College, London to do a Ph.D. on the laser spectroscopy of plasmas. He received his doctorate in 1983 and worked as a postdoctoral fellow at the Rutherford-Appleton Laboratory on the development and application of coherent radiation sources for vacuum ultraviolet spectroscopy, before returning to Australia in 1984. In May, 1985 he was selected by the Australian Academy of Science as the representative at the 12th meeting of Nobel Prize Winners in Physics at Lindau, Germany.

The pressure is on. There are cutbacks, staff ceilings, budget restrictions — people are worried about their jobs. There is pressure to be "applied", to be "relevant". There is pressure to publish, to keep up with one's field. How often, then, do we have the chance to lift our heads, take a steady look around, and see where it is that we are really going?

This opportunity arose for me at Lindau, Germany, in July of this year. On this picturesque islet set in the tranquil waters of Lake Constance in the shadow of the Swiss Alps, 16 Nobel prize Winners from 7 different countries met to discuss the latest developments and new directions in physics. For the first time in the history of these meetings, communiques had been sent to the foreign diplomatic missions in Bonn inviting a young scientist from each country to attend the meeting. I was fortunate enough to be one of them.

This report details the personal impressions gained from the meeting, often in areas outside my own field (I therefore apologize for any oversimplification in advance). What I hope has resulted is an indication of the answer to the question posed by the title. In an age where the usefulness of abstract or fundamental science is being questioned, it is relevant to ask whether we are now working simply on gaps in our knowledge of a field, the boundaries of which may have already been reached.

LINDAU

Later in the article we will return to this question. Firstly though, a brief rundown of the background to the conference, followed by a summary of the talks and discussion groups that went on during the week.

Count Lennart Bernadotte, patron of the Lindau meeting, was born in 1909 as a member of the Swedish Royal Family. In 1932, he gave up his claim to the throne to marry a commoner. Since then he has lived in exile on the island of Mainau in Lake Constance. His isolation was not however complete, and following World War II he was approached by a number of German scientists who were concerned that their country's isolation from the world would hinder the rebuilding of its once outstanding scientific community. The link via Count Bernadotte and the Swedish Royal Family to the Nobel Prize Committee was a natural path by which a meeting of Nobel Prize Winners and German scientists could be fostered. So it was that in 1951 the first meeting of 7 NPWs in medicine from Germany and Sweden (together with some German scientists) took place in the island town of Lindau at the other end of the lake to Bernadotte's palatial residence.

The meeting was so successful that the following year it was decided to hold a similar gathering of NPWs in physics, and then again the next year in chemistry. However, after several of these clubby conferences Count Bernadotte felt that something was missing. In order to be successful, such meetings had to pass on the knowledge and inspiration of the NPWs to the new generation of scientists that would build Germany's future. So invitations were sent out to German universities, inviting students and young scientists to attend the triennial meeting at Lindau in the respective disciplines. Gradually people from other European countries filtered through to the conference which by now had grown to over 500 participants a year.

However in 1985, for the first time, the German Foreign Ministry decided to invite young scientists representing countries overseas to participate in this unique forum and discuss issues at the forefront of modern physics. As Count Bernadotte, in his opening address, read out the list of overseas participants, there was a pause in the translation (as the interpreter waited for the inevitable verb at the end of the German sentence), in which the words "und sogar Australien" (and even Australia) could be heard. Thankful that we had now been considered to have entered the international arena in modern physics, I was then able to sit back and listen to the rest of the opening addresses.

MORALITY, POLITICS AND PHYSICS

Opening addresses are usually boring, particularly when given in a foreign language. At Lindau neither of these statements was true. Firstly, the fluency and faithfulness of the interpreters was so good that when
a speaker said “Damnit I dropped my viewgraph”, over the infra-red headphone receivers came “Damnit I dropped my viewgraph”! Secondly the speakers had some profound words to say, particularly on the recurring theme of the physicist’s responsibility for the development of means of mass destruction.

The Mayor of Landau set the scene right from the beginning when in his welcoming speech he referred to: “the misdevelopments (sic) of science such as nuclear arms about which the present young scientists are so justly concerned. Let us hope that this is the spirit with which this meeting will be conducted.”

Not to be outdone, the Deputy Prime Minister of Bavaria (the state in which Lindau is situated) commented that: “the abuse of science cannot be prevented by scientists but — they must actively search for humanitarian uses as well”.

However, the Federal Minister for Research and Technology took part of the onus of responsibility upon government, saying that: the state must put requirements on the type (both academic and moral) of work that is done under their auspices — the physicists must live up to this.

We were not being allowed to forget, by the elder statesmen of a country that vividly remembered the destructiveness of the last war, that physicists had a role out of all proportion to their numbers in the prevention (or otherwise) of the next.

Having just arrived from a nation in which our own politicians had recently been honing up the razer of relevance, it was absolutely astounding to listen to the next speech, which perhaps gives some indication as to why the role of research in our two countries is so far apart. The Minister for Science and the Arts in the neighborhood of Baden-Württemberg had this to say: “Those who spend public funds must also look at economics, but this is not our only concern as we must create a favorable atmosphere for such research. Not only excellent material preconditions [must be provided], but also the personal involvement in research — i.e. contact. Money cannot simply buy a university, but in times of hardship we must reduce the impact to maintain the necessary infrastructure — in particular to exempt universities from staff cutbacks and ceilings to enable young scientists to keep coming through for the benefit of research.”

Let us hope that such sentiments reach, and influence, the politicians of this country.

**THE WINNERS**

Great people in any aspect of human endeavour possess not just a special ability within their own field, but also something extra. With the NPWs it was generally one of three things: luck, dedication or political astuteness.

It was encouraging to hear time and time again what a significant part luck had to play in the scientific career of many of the speakers, usually in the form of being born in the right era or of meeting and collaborating with the right person. In general the people who acknowledged this contribution to their success showed the humility that comes with true greatness. Almost all the speakers showed by their enthusiasm and track record their dedication to their work and ideas, some of which flew against the mainstream of physical thought at the time. Still others showed an uncanny awareness of things around them in an ability to pick out germane content, to interact with people or to organize vast and complicated projects. Such people would have stood out in any field whether it was business, administration or politics.

But despite all this the NPWs were always approachable. In addition to the formal presentations there were a number of informal discussion meetings as well as the opportunity to discuss things over the conference dinner. On these occasions it was possible to question the NPWs more closely on aspects of their work as well as to encompass matters of a more political nature. This was perhaps not as difficult as it seemed with over 500 people and only 16 Laureates, since the vast majority were German diplomats and graduate students who did not have sufficient background to discuss many of the more involved topics. Although those of us with more experience were careful not to hog the floor, there was often the opportunity for closer questioning. In particular I was able to have useful discussions with Bloembergen and Siegbahn in areas more closely related to my own field.

Altogether 12 talks were presented, some on past reminiscences and others on future directions. In addition 4 NPWs who did not speak were present: Pavel Cherenkov (USSR), who with Igor Tamm and Ilya Frank received the 1958 award for the discovery and interpretation of the Cherenkov effect; Ernst Fischer (FRG), who received the 1973 Prize for Chemistry with G. Wilkinson (GB); Emilio Segre (US) who shared the 1959 Prize with Owen Chamberlain (US) for the discovery of the antiproton and S. van der Meer (NL) who was awarded the 1984 Prize jointly with Carlo Rubbia (I) for the discovery of the W and Z particles. Van der Meer was later to take part in a panel discussion on bases of modern physics, and his co-Laureate Rubbia was unable to present his talk because of outside commitments.

**MOSSBAUER:** The invited papers started with Rudolf Mossbauer (FRG) whose discovery of the recoil-less resonance absorption of gamma radiation by nuclei embedded in a crystal lattice earned him a share in the Nobel Prize in 1961 along with Robert Hofstadter (US). Mossbauer spoke on the rest mass of the neutrino with its consequences for the closure of the universe. He mentioned that current theoretical predictions place the neutrino mass at somewhere between 10^{-6} and 10^{-5} eV, with the cosmological upper limit being at 100 eV from the known lifetime and stability of the universe. A massive neutrino raises the question of conservation of baryon/lepton numbers, and there is the further question of whether neutrinos are distinguishable (Dirac) or indistinguishable (Majorana) particles. These were, in his mind, the important questions for the future, together with an explanation for the anomalously low (by a factor of 3-4) solar neutrino flux. His current investigations into the neutrino mass (by a technique based on neutrino mixing whereby oscillations in the neutrino energy spectrum as a function of distance from the radiation source are measured) have so far suggested an upper limit of 10 eV.

**BARDEEN:** Only one person has won the Nobel Prize in Physics twice, and that is John Bardeen (US), first in 1956 with William Shockley (US) and Walter Brattain (US) for the discovery of the transistor, and again in 1972 with Leon Cooper (US) and Robert Schrieffer (US) for their theory of superconductivity. His talk was a personal account of the development of solid state physics in the late twenties and thirties when people were applying quantum mechanics with extremely productive results.

**SCHRIEFFER:** Bardeen was followed by his former student Robert Schrieffer who spoke on the quantum Hall effect and fractional charge. In semiconductors, discrete changes in the conductivity as a function of field strength have been observed in high magnetic fields, a phenomenon which has been explained as a result of
the collapse of zero-field energy levels into Landau levels with exclusion principles allowing only the occupancy of every third site. The result is a fractional charge phenomena requiring 3 charges, which calls for a new formulation of particle statistics.

MOTT: The theme of solid state physics was continued by Sir Nevill Mott (GB), who shared the 1977 Prize with Philip Anderson (US) and John Van Vleck (US) for their fundamental investigations of the electronic structure of magnetic and disordered systems. Mott's talk was again a personal history, in which he acknowledged the good fortune he had to work in a small pre-war physics community, which reaped the benefits of the early application of quantum mechanics. His crowning achievement, in Mott's own eyes, was to bring theory up to date with 300 years of experiment. He was able to explain how, when bronze age man introduced impurities into copper, the movement of dislocations was thereby prevented, thus strengthening the alloy.

LAMB: Quantum mechanics was also the subject of the presentation by Willis Lamb (US) who won the 1955 Prize (shared with Polkarp Kusch (US)) for his work on the hyperfine structure of hydrogen. Lamb gave an amusing talk on Schroedinger's cat.

FRANK: Lamb's speech followed an earlier presentation on some aspects of neutron-nuclei interactions by Ilya Frank, who shared the 1958 Nobel Prize with Cherenkov and Tam for the discovery and interpretation of the Cherenkov effect.

SIEGBAHN: Of more interest to me was the speech by Kai Siegbahn (Sweden), son of the 1924 Prize Winner Karl Siegbahn. Kai Siegbahn won the 1981 Prize (together with Arthur Schawlow (US) and Nicholas Bloembergen (US)) for his development of high resolution electron spectroscopy for chemical analysis (ESCA). The technique developed by Siegbahn was to irradiate a chemical sample using a monochromatic beam of ionizing radiation (electron beams, x-rays, UV photons etc.) and to observe the resulting electron spectrum in high resolution. The expelled electrons (from shared states in particular) have a spectrum that is highly sensitive to the orientation and composition of the surrounding atoms. ESCA has been applied to gases, liquids and surfaces, but it is the last area that Siegbahn sees as being of most interest in the future. Already ESCA diffraction is used to study surface properties whereby electrons expelled from near the surface produce a diffraction pattern determined by the crystal structure. The effect of molecules absorbed onto the surface could also be studied in this manner, as can the diffusion of metals through surfaces as a function of time. Other new developments are centred on ESCA in molecular beams, where for example free radicals can be produced by UV irradiation. The structure of molecular clusters in beams is also an area of highly topical interest, and fragmentation studies using ESCA are planned. Finally the powerful techniques of high resolution laser spectroscopy and ESCA are about to be married with beam experiments to do dynamic studies of molecular excitations.

BLOEMBERGEN: Nicholas Bloembergen, Siegbahn's co-Laureate, spoke on the collision induced coherence of light, an anomalous phenomenon that arose out of work in laser spectroscopy for which Bloembergen won his Nobel Prize. When carrying out


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a Raman-like experiment between two energy levels with a near resonant third level, the collisions which contribute to broadening of the levels can, at high pressures create a resonance in the Raman spectrum. This phenomenon is anomalous in that it shows a coherent effect induced by collisions, rather than being destroyed by collisions as is often the case. However, this resonance does not attribute any mysterious cooperative behaviour to the colliding particles, but rather indicates that the collisions perturb the energy levels in a way as to bring about an enhancement in the normally non-resonant transition. Bloembergen feels that the field of non-linear optics was stimulated by the advent of lasers to the extent that there is still enough interesting physics in this area of "small" science to keep physicists occupied for at least another generation. Like Siegbahn, Bloembergen also saw surface studies as being one of the growing applications of laser spectroscopy. He is interested in using lasers to irradiate and heat the surface, as well as to probe the surface conditions using very fast (sub-picosecond) pulses to determine the temporal evolution of the surface structure.

TING: The subject of high energy nuclear physics was addressed from an experimentalist's viewpoint by Samuel Ting (US) who with Burton Richter (US) was awarded the Nobel Prize for the independent discovery of the J /ψ particle. Ting outlined some of the main questions still to be answered in the search for elementary particles. On strong interactions: how many quarks exist (6?), what is their size (<1E-18m?), and what are the properties of gluons? For electromagnetic interactions: how many types of spontaneous pair production are there (electrons, muons and r?); what is the size of the electron (<1E-18m?), are there excited electrons? And on weak interactions how many W and Z particles exist?; how many kinds of neutrino exist (3?); and do Higgs particles which explain the origin of masses, exist? Ting then went on to outline the enormous and complex plans for the LEP (electron-positron collider) with its 57km diameter ring and massive communications network which will allow information exchange among the 55 participating nationalities (including China, the US and the USSR for the first time). This device will probe beyond 100GeV to look for the Higgs particle as evidence of symmetry breaking, which together with the W and Z particles support for gauge invariance will test the current theoretical ideas on elementary particles and their interactions.

WEINBERG: A man who has contributed much to the present picture of particle physics is Steven Weinberg (US), who in 1979 together with Abdus Salam (Pak.) and Sheldon Glashow (US) received the Nobel Prize for the unification of the weak and electromagnetic forces. Weinberg spoke about the subsequent frustrating theoretical impasse in the development of a true grand unified theory that links the strong, electromagnetic and gravitational forces and supersymmetry. He attributed this impasse to the use of only four dimensions, but recent revivals of formerly discarded theories may provide a breakthrough by the use of higher dimensions. As one example, the Kakuza-Klein (1920's) theory of compact dimensions, in which a one dimensional line may in reality be a two dimensional cylinder with its radius being too small to observe (<1E-32m), as currently being examined. Compact dimensions were incorporated in the revival of the so-called string theories. At the present time a 10 dimensional theory (with 6 compact dimensions) may be coming close to explaining gravity.

HOFSTADTER: The theories of physics in higher

dimensions were in sharp contrast with the completely applied presentations of the last two speakers. The first of these was Robert Hofstadter (US), who received his Prize in 1961 for discoveries of nuclear structure using electron scattering. His present work concentrates on using a byproduct of the accelerators he employed for his Nobel Prize studies — synchrotron radiation. At SLAC he has developed a technique for non-invasive imaging of arteries which shows great promise for diagnosing arteriosclerosis. Patients are injected with an iodine solution, and the monochromatic x-ray beam from the synchrotron is used to take images above and below the iodine K-edge (where the absorption by bone and water is relatively constant). This is followed by computer subtraction of the two images. In one example, the intricate detail of the blood vessels shown in the processed image of a pig's heart were astounding. Further refinements of the technique for human application may result in early diagnosis of heart and arterial disease which causes 1 million deaths each year in the US alone.

GIAVER: Another change of field was evident in the present work of Ivar Giaever (US), who received his Prize in 1973 together with Brian Josephson (GB) and Leo Esaki (Japan) for the discovery of tunnelling in superconductors. Giaever is now a biophysicist and studies the effects of fields on living matter, a topic which received prominence recently on the ABC program "Four Corners". Magnetic fields, he assures us, no matter what their strength, have no observable effects on anything except magnetotactic bacteria (which have small magnets inside them). He then spoke on cell behaviour in electric fields, and described an experiment in which both healthy and cancerous human cells were placed between two electrodes. The magnitude (mV) and Fourier spectrum of the EMF were measured, and the cancerous and normal cells were found to be distinguishable by the amount of random noise generated by cell movement and metabolism (that due to cancer cells being the greater). More importantly, this method could be used to differentiate between the reaction of normal and cancerous cells to the presence of cancer-curing drugs. This observation led to his final conclusion: "that there is no difference between biology, chemistry and physics".

HOLES?

That provocative statement brings us back to the question — where are we going in physics? The focus for this debate at the meeting was the Nobel Foundation on "High energy physics: bases of modern physics" between Ting, Moscaus, Weinberg and Van der Meer. Modern physics has now reached a stage similar to that encountered earlier this century when the behaviour of matter was thought to be well understood in terms of electrons, protons and neutrons. However the different now is that the theory is more predictive, to the extent that e.g. neutral particles can be predicted and in a theoretical framework that explains most of the things we know about elementary particle physics. Should we be satisfied with this?
regard a theory as being more useful if they take it as true, and vote with their feet. Ting continued by saying that if we do things precisely enough then, so far, we have always seen something new. Besides, there is a class of experiments such as time reversibility and the proton lifetime which aren’t a check of present theory.

But how far should we go? Weinberg said that it was important to get above 100 GeV in order to check for the predicted Higgs particle at about 250 GeV. He would also like experiments to search for a composite W and Z particle up to about 1 TeV. Van der Meer commented that an international consortium should be formed to build the SSC proton-proton collider (20 TeV) at a cost of US$3.6 billion. Ting and Weinberg agreed but emphasised the great difficulties fund raising would face in the present economic climate. In addition to the vast organisational difficulties, there is now the serious and acknowledged problem in “big” physics of attracting and training young physicists, who may only spend 3 years on a 5-year experiment building a part of a particle detector. Van der Meer thought that the future of particle accelerators lay with linear electron-position colliders, using wigglers, lasers or plasma wave accelerators to produce GeV, and Mossbauer added the possibility of using cosmic rays as a way of studying very high energy particle physics. However, it may be, as Weinberg said, that the single Higgs particle is all that there is to see up to 1 TeV, and that there may be no more interesting energy scales up to 1 E18 eV — well beyond the capacity of mankind to do further experiments.

So where are we then? If the Higgs particle is discovered and nothing unexpected is seen, if the mass of the neutrino is determined, and if gravity is finally quantized and unified with the other forces, then have we at last reached the boundaries of fundamental physics and the cosmology with which it is inextricably bound? Will we then know everything that is within our power to know and to verify experimentally? And will the rest of our endeavours be but the filling in of details in the holes that are left in our present knowledge? This may well happen, but the general feeling at the meeting was that there are a good many years of physics left before these boundaries are finally reached.

And if we are just filling in holes — then so what? As Weinberg said, “Even though we know the fundamental laws, the physics of what is happening e.g. the Navier-Stokes equations, is still interesting”. This discussion with Siegbahn and Bloembergen on surface physics and complex molecular physics showed that there is still plenty of interesting and important physics to be done on large scale complex systems. As Mott pointed out, particularly with the development of massive computing power, we may find that some forms of complication lead to simple generalizations (as occurred in amorphous semiconductors), allowing even the study of biological systems. The application of physical thought and techniques to the understanding of chemistry and biology has already been amply demonstrated by Hofstadter and Giaever. So it might be that science will turn full circle to the days before such distinctions were made, and once again we shall all become students of the one subject — natural philosophy.

ACKNOWLEDGEMENTS

I would like to thank the A.C.T. branch of the A.I.P. and the Research School of Physical Sciences, A.N.U. for their assistance in enabling me to attend the Lindau meeting.

I would also like to thank the Kuratorium fur die Tagungen der Nobelprizestrager in Lindau for their invitation, and to repeat my thanks to Count Bernadotte for helping in part to reduce the isolation due to distance and finance that befalls young scientists in this part of the world.

REFERENCES


and dyes, Novel schemes, Transverse effects, and Theories. List indicates the broad area involved and reminds us that Optics is a most diverse subject blurring into Solid State Physics, Atomic Physics and other branches of Physics. In reviewing a book of this type one must ask whether the material is useful and interesting and whether it serves as a useful report on the conference for those who did not attend.

There is a wealth of interesting material in this book and I believe that it is useful to have these articles gathered together in one volume. A crucial fact relates to the age of this field; because this is a relatively new branch of optics, the work is not too highly developed and it is simple to go back to its origins. This means that the papers may be read and used by people without a very specialized background, which is usually not the case with highly technical conference proceedings. Some of the papers, for example “Chaos in optics” and “Nonlinear optical interfaces”, are reviews and most papers seem to be nicely introduced and motivated and well referenced. Many fascinating experiments and ideas are reported to stimulate the imagination: try ”Instabilities and chaos in TV optical feedback” for analogue methods relating to physics, biology and nonlinear differential equations.

A book cannot replace attendance at the conference and the associated personal contacts. Realizing this, the Editors have included a report of a Panel Discussion dealing with the future of optical bistability research and its importance in physics in general and in engineering. This gives some indication of the feelings among the delegates and reveals many avenues for future development. Anyone wishing to follow these leads could very profitably peruse the articles in this book.

Reviewed by B.M. Spicer, School of Physics, University of Melbourne.

This book presents an intermediate level treatment of the physics of quantum phenomena. It is not always descriptive, though many topics are introduced using an historical approach; at the same time it does not concentrate on providing a formal mathematical treatment. Its coverage of material is quite good, given that its stated aim is to introduce the reader to the principles of modern physics. Having done that it then proceeds to discuss quantum phenomena in illustration of the principles. It is concerned almost completely with quantum phenomena, and, consequently, the chapter on Special Relativity appears to be rather out of place; it has no obvious connection to the general flow of the argument.

The material of this book ranges from atomic and molecular phenomena through to those of particle physics. It was surprising to see molecular spectra discussed without any reference at all to the Born-Oppenheimer Approximation, which justifies the classification of these spectra into electronic, vibrational and rotational. Further, and understandably so, the treatment of nuclear and particle physics is rather more descriptive than that of atoms and molecules. The coverage of material is sufficient to provide examples of the principles the author sets out to present and then exemplify. However, it is not so broad as that presented, for example, in Eisberg and Resnick's "Quantum Physics", and this latter book would have to be preferred if discussion of a broad spectrum of quantum phenomena is desired.

The author not only looks to description of phenomena as connections with the "real world". He is to be applauded for including discussions of some classic experiments, for example the Millikan oil drop experiment, and the Cowan-Whitehead detection of the antineutrino. He also, selectively, discusses applications of several phenomena, for example, the Mössbauer effect, and positron annihilation.

The book provides a good basis for a course which introduces students to quantum phenomena, although the better students may also need to refer to other texts which provide a somewhat wider range of topics.

Reviewed by J. Mahanty, Research School of Physical Sciences, The Australian National University.

This collection of twenty articles and ten abstracts represent the proceedings of the NATO Advanced Study Institute on Collective Excitations in Solids held at Erice, Italy in June 1981. Collective excitations in a many-body system are fascinating in that many interesting analogies arise between different kinds of excitations, and useful simplified models of the system for study of specific phenomena can be constructed. The article by A.A. Lucas on scattering of fast particles by plasmons gives a good example of such an approach. Notable among the other articles are the ones on exciton physics by R.S. Knox, magnons and solitons by D.C. Mattis, polarons by R. Evard, polaritons by R. Loudon, and surface collective excitations by G. Benedek. All the articles are extremely readable, starting at an introductory level and bringing the reader up to the latest developments in both theoretical and experimental aspects. The concluding article on present trends in collective excitations by F. Williams is a bit inadequate as a digest of the material covered by the other authors and as a statement of the trends in the field. The reader should draw his own conclusions. The excellent overview of the field that the articles in this book provide would certainly stimulate graduate students and researchers alike.

Reviewed by D.M. Eagles, CSIRO Division of Applied Physics, Lindfield.

This book reports the proceedings of the third of a series of summer schools on polarons and excitons, held at approximately ten-yearly intervals. The first was at St Andrews in 1962, the second at Antwerp in 1971, and the third again near Antwerp in 1982. Because of the interests of the organisers, the largest part of the proceedings (seven chapters) is concerned with Frolich polarons (large polarons in ionic or partially ionic crystals). There are two chapters on excitons (R.J. Elliot and W. von der Osten), one on electron-phonon liquids (F.L. Reinecke), one on small polarons in the chalcogenide glasses, and one on the theory of (large) polarons associated with surface electrons above a liquid He film. Since there is probably at least as much experimental work in the world on small as on large polarons, the bias towards large polarons should perhaps have been indicated in the title. There is no discussion of so-called "polaronic" in polyacetylene (which are really bound pairs of a neutral and charged soliton interacting with the lattice, and should in the reviewers opinion be called bisolitons) or of "magnetic polarons".

The three experimental chapters on Frolich polarons are concerned with optical properties of polarons in magnetic fields in InSb (R.A. Stradling), and on properties of silver halides in strong electric fields and in crossed electric and magnetic fields (S. Komiyama, T. Masumi). The four theoretical chapters on Frolich polarons include discussions of transitions between types of polaron wave functions in high magnetic fields, transport in low and high electric fields, bound polarons (J.T. Devreese), cyclotron resonance, relaxation of hot polarons (R. Evard), coupled plasmon-phonon modes (W. Richter), and functional integral methods (J. Adamowski, B. Gerlach and H. Lischke).

The chapter by K.L. Ngai on chalcogenide glasses is likely to be the most controversial. There are apparently two conflicting models for transport in the chalcogenide glasses, one due to N.F. Mot, and the other a small-polaron model developed in particular by D. Emini. Dr Ngai comes down firmly on the side of the small-polaron model, and also argues in favour of a unified model of relaxation at low frequencies. He omits to mention that a similar model has also been developed by L.A. Dissado and R.M. Hill, colleagues of Professor A.K.J. Jonscher of Chelsea.
The chapter by S.A. Jackson includes a review of a theory of his own and P.M. Platzman on a predicted transition from a low to a high-mobility state for polaron on He films as the coupling constant or film thickness is changed. Such transitions have been observed recently by E.Y. Andrei (Phys.Rev.Lett.52, 1449 (1984)), who finds a mobility increase by a factor of 10^6 as the film thickness increases from 80 to 100 nm.

The book should be useful to workers in the field of large polaron in the bulk of materials, but, for workers on excitons, small polaron or surface polaron, it is doubtful if it is worth buying for the one or two relevant chapters.


The thin red line representing progress in physics is embedded in a thick and tangled web. This is no news to the professional historians of the subject but the rest of us, who learn the folklore from old-timers or from historical introductions in textbooks, can easily lose sight of all but the thin red line, albeit tortuous, with many unexpected twists and turns.

This book, written by a professional historian of physics, sets out to show us the tangled web of false hypotheses, wrongheaded dogmas, incorrect observations and bad experiments which surround the occasional flashes of insight, crucial experiments and pertinent observations. It, incidentally, also highlights the interdependence of science and technology in showing the leapfrogging of experimental technique and apparatus with the technology which itself emerges from the experiments.

The context is wave-particle dualism and the book opens with a statement by H. Hertz: "For all practical purposes the wave theory of light is a certainty" (1896). Experimental work around the turn of the century on the transfer of energy from radiation to matter culminates in Einstein's hypothesis of light quanta with particle-like properties. (1905). Why then the great fuss about Compton's discovery of the famous effect named after him? (1922). Where was the thin red line in the intervening seventeen years? Answer: It was embedded in the confusing web of theories and experiments which followed the discovery of x-rays and gamma rays which showed now wave-like, now particle-like properties.

Read all about the conflict between the British mechanistic world-view of G.G. Stokes, J.J. Thomson and W.H. Bragg, on the one hand, and the abstract German world-view of A. Sommerfeld and his successors. Read all about the Impulse Theory which refused to lie down and die. Read all about the ingenious Triggering Hypothesis, Bragg's Neutral Pair Hypothesis, and so on, and so on. It all reads like a detective story, complete with false clues, except that we all know the ending. Or do we?

In one way the end came with the increasing realisation that electrons and other material particles exhibited the same dual nature, which J.J. Thomson described as a struggle "between a tiger and a shark, each is supreme in his own element but helpless in that of the other" (hence the title of the book). In a more definitive way, the end came with the triumph of the abstract world-view represented by Quantum Mechanics. But has the last word been spoken? The Epilogue to this fine book opens with the following quotation from Dante's Inferno: "We'll wait awhile, the master said, 'that thus our senses may grow used to this strong smell, and after that, it will not trouble us.'"
physics at Göttingen in Germany where he pursued the application of X-ray interference to the study of crystal structure and produced a masterly paper, "Scattering of X-rays" which led him to conclusions regarding the relationship of the interference pattern to the regularity of electron arrangements in the atoms. He collaborated at Göttingen with the Swiss physicist, Paul Scherrer, on experiments in X-ray scattering which led years later at Leipzig to successful measurements on isolated molecules of CCl₄. In 1915 he was appointed Editor of the 'Physikalische Zeitschrift', a position which he held for more than 25 years.

In 1920 Debye returned to Zurich as Professor and Director of the Physical Institute of the Federal Institute of Technology where he studied the Compton Effect, the theory of strong electrolytes and adiabatic demagnetisation. His 1923 paper, 'X-ray scattering and quantum theory' clearly anticipated the advent of quantum mechanics and wave mechanics. It was at the end of this period, when he accepted the appointment in 1927 of Director of the Physical Institute in Leipzig at the age of 43 that Debye's major contributions to the advancement of physics and chemistry were completed. He succeeded Einstein in Berlin in 1934 at the Kaiser Wilhelm Institute and was influential in changing its name to the now familiar Max Planck Institute.

With the Second World War in progress, Debye was obliged by the German authorities to make a decision between German citizenship or resignation from the Institute. With the opportunity of an invitation to deliver the Baker Lectures at Cornell University, Ithaca, he was able to escape via Italy to the U.S.A. in 1940. There he was appointed as Head of the Chemistry Department where he remained until his retirement in 1952. He made contributions to the development of synthetic rubber during the war and the light scattering properties of polymers from which he determined their molecular weights. He became an American citizen in 1946.

His ties with Germany transcended the politics of the day and he was recognized in the Physikalische Zeitschrift in 1944 on the occasion of his 60th birthday. He was still its editor when in 1945 its last issue appeared. To him there was no boundary between physics and chemistry, and this summary of Prof. Rasche's lecture touches on only the more outstanding of Debye's achievements in a lifetime constantly probing the boundaries of physics and chemistry of the time. He was a member of all leading scientific societies and the recipient of all major awards in chemistry. His outgoing personality kept generating enthusiasm and goodwill throughout his life, which came to an end in 1966, at the ripe age of 82.

Telescope to track Halley's comet

The once-in-a-lifetime appearance every seventy-six years of Halley's Comet has captured the imagination of astronomers, historians and laypeople alike since its first recorded appearance in 240 BC.

Perhaps its most famous appearance was in 1066 AD, when it was regarded as a sign from heaven by Normans and English alike and woven into the Bayeux Tapestry. Edmond Halley witnessed the return of the comet in 1682 and later predicted that it would be seen again in 1758. The triumphant return of what was then known as Halley's Comet in early 1759 established the identity of comets as members of the solar system, and was final proof of Newton's Law of Gravitation.

UNSW physicists will follow this honourable tradition by using the School of Physics' new Automated Patrol Telescope to create a pictorial record of changes in the tail of Halley's Comet throughout its 1986 appearance. The team working on this and related projects is composed of Senior Lecturers, Dr John Storey and Dr Louise Turtel; Lecturers, Dr Peter Mitchell and Dr Zdenek Kviz; and PhD student, Mr Paul Payne.

The telescope is constructed from a Baker-Nunn satellite tracking camera (built for NASA in the first wave of the United States' exploration of space), in which the original photographic film facility has been replaced by a modern detector. The camera was donated to the School of Physics by the Smithsonian Astrophysical Observatory.

The system is controlled by a micro-computer which is programmed to move the telescope to a pre-determined position, carefully scanning that section of sky and then sending commands to the detector.

'The computer has enough intelligence to know if the telescope has seen anything significant', says Dr Storey. 'If it does find something it will go back and re-observe and check what it has seen. If we didn’t endow the computer with a great deal of discretion we would be swamped with information', he says.

The detector is a cooled GEC charge-coupled device (CCD) of scientific grade which sees an area of sky 1.4 by 0.9 degrees, or about five times the projected area of the full moon. It has novel readout electronics and can either operate in the normal TV mode, or can be integrated and then be digitized, or, finally, can be organized to send information on half of the field back to the control computer while the light falling on the other half is being stored.

The telescope is unique in that it combines a wide field of view with the electronic detector, says Dr Storey. It is this feature which makes the telescope ideal to carry out its second scientific objective: identifying the sources of mysterious bursts of enormously intense gamma-rays coming from outer space which were first recorded more than ten years ago by the US military on the lookout for nuclear explosions on earth.

'We don't know what the source of these gamma-ray bursts look like — and present telescopes cannot pinpoint where they come from', says Dr Storey.

This telescope is able to start with only a vague notion of an image, pinpointing this down to a single pixel (picture element). 'We are hoping that the objects will give out flashes of light — if they do, the telescope will be able to pinpoint them', he says.

Theorists now believe that the gamma rays are caused by stars with huge gravitational pull swallowing other stars or material around them. 'We hope to either confirm or dispute this theory', says Dr Storey.

'We will also be on the lookout for supernovae in other galaxies and the telescope will monitor up to 100 galaxies each night, like a shepherd doing rounds of sheep.'
LATEST IDEAS IN PHYSICS

Highlights from the Papers Presented at the APS April Meeting in Crystal City, VA, April 24-27, 1985

Superstrings

One of the chief goals of theoretical particle physics is the development of a theory that can account for the four forces of nature: gravity, electromagnetism, and the strong and weak nuclear forces. So far there has been partial success. Steven Weinberg, Sheldon Glashow, and Abdus Salam won a Nobel Prize for their electroweak theory which fits the electromagnetic and weak forces together in a single framework. Other scientists are trying to integrate the electroweak and strong forces into a "grand unified theory." This theory would not actually be "grand" since it would not assimilate gravity. "Supergravity" is a theory, still in a formative stage, that does address the problem of gravity; it call for the existence of a whole new family of particles, some of which are being sought at the European laboratory CERN and elsewhere.

Now there is another contender. Michael Green of University of London outlined the "superstring" theory, the principal features of which are these: the dimensions of the universe consist of the usual 4 (3 for space and 1 for time) plus 6 more (which cannot be observed since they shriveled up shortly after the big bang) for a total of 10; elementary particles such as quarks, leptons, and gauge bosons are regarded not as pointlike but as tiny, one-dimensional strings about 10^-19m long; all four forces are united in a single framework that is reconciled with quantum mechanics (previous theories have not succeeded in bringing gravity and quantum mechanics together); the property (known as "chirality") that the laws of physics are not symmetrical under reflection in a mirror is preserved; the theory appears to have no "infinities" (nonsensical terms appearing in the calculation of interaction probabilities) or free parameters (factors that can be adjusted to make the theory fit the experimental evidence); the theory calls for the existence of a new class of matter, called "shadow matter," which only interacts gravitationally. Some astronomers associate shadow matter with "dark matter," the non-luminous stuff that seems to lurk in or around many galaxies.

Many theorists seem excited by the superstring theory. It might at last be a theory that unifies the four forces of nature without incurring the kind of difficulties that have plagued supergravity so far. It may be difficult, however, to validate the model experimentally, so acceptance of the theory will take some time.

The Early Solar System

Douglas Lin of the University of California at Santa Cruz summarized the growing consensus of opinion about the origin of our solar system and the formation of planets. The new ingredient in this theory is the notion that the primordial solar nebula — the swirling disk of gas from which the solar system formed some 4.6 billion years ago — was turbulent. The gas temperature at the inner part of the core reached more than 1000K. When condensation of matter began, planet formation in the inner, hotter region resulted in relatively light rocky bodies (the terrestrial planets: Mercury, Venus, Earth, and Mars), while farther out, where it was cooler, the giant planets (Jupiter, Saturn, Uranus, and Neptune) could attract gas and hold it around a small rocky core.

Eventually gaps opened up in the plane of the nebula disk and the planetary growth process came to a halt. According to Lin the whole process of sorting matter into planetary systems must have happened on a timescale of only about a million years. For this reason, Lin suggests that efforts at observing planetary systems in the making should concentrate on the youngest stars in the galaxy.

Chaos

In recent years the word "chaos" has come to take on a rather specialized meaning in physics. A chaotic system is one whose behaviour in time may be extremely complicated and nonperiodic but can nevertheless be characterized by differential equations. The study of the dependence of the solutions of the equations on initial conditions and the study of the onset of chaos in such systems as fluid flow, population biology, Josephson junctions, and the weather has been of increasing importance to scientists.

At the meeting the effects of chaos in several other systems were reported. Jack Wisdom of MIT discussed three examples of chaotic behaviour in the solar system. First, Saturn's satellite Hyperion — a oddly shaped moon twice as long as it is wide — is tugged by another of Saturn's moons, Titan, in such a way that it tumbles chaotically in its orbit, significantly changing its spin rate and axis orientation in only a few 21-day trips around Saturn. A second example of chaos is the pattern of asteroid orbits. Wisdom found that there is a chaotic zone in which asteroids with orbital periods commensurate with that of Jupiter may spend millions of years in nearly circular orbits and then suddenly adopt highly elliptical orbits, where they might encounter planets such as Mars or the Earth. Yet another example of chaotic behaviour is the transport of meteorites to the earth's surface arising from the perturbation of asteroid orbits described above.

Carson Jeffries of the University of California at Berkeley spoke about the onset of chaos in several solid-state systems. His study of semi-conductor diodes, for example, showed that the diode may at first show simple periodic behaviour but will later undergo an abrupt change, as some driving parameter (a voltage, say) is increased, so that afterward its period of oscillation will be twice as long. As the driving parameter is increased further, the period doubled and doubled again, until eventually the diode's behaviour appeared chaotic. This "period-doubling" behaviour of a system on its way toward chaos has been observed in many other physical systems, and agrees well with the theories of Mitchell Feigenbaum, a Cornell physicist, who has pioneered study in the theory of chaos.

Proton-Antiproton Collisions

The UA1 and UA2 (short for Underground Areas One and Two) experiments at the CERN proton-antiproton collider near Geneva, Switzerland have produced some spectacular results in the past few years. First, in 1983 came the discovery of the W and Z
particles, the carriers of the weak nuclear force. Then in 1984, combing the same set of data, the UA1 scientists found evidence for the existence of the top quark. There were also hints of other assorted “anomalous” events.

Recently, during a running period from September to December 1984, UA1 and UA2 recorded twice as much data as in all previous runs of the proton-antiproton collider. Furthermore, in this latest round, the total collision energy was 630 GeV instead of the previous 540 GeV. With more data at higher energies, expectations of amazing new results were high.

The new data, at least that portion of it that has been fully analyzed so far, generally corroborates the older data and does not appear to hold any surprises. Indeed, Carlo Rubbia of CERN and Harvard University, leader of the UA1 team and Nobel prize winner in 1984, urged caution in the interpretation of the new data. This data sample includes 15 so-called “monojet” events, collisions in which an energetic jet of particles were observed to spray out on one side of the UA1 detector without an observable matching jet on the other side. These 15 events cannot be accounted for by conventional physics explanations.

Regarding top-quark events: in previous runs, six events had been observed, three containing muons among the top-decay products. In the 1984 run, seven events with electrons were seen. Events with muons had not yet been analyzed. The top-quark mass is estimated to be somewhere in the range of 30-50 GeV.

Marcel Bannier of the Saclay Laboratory in France offered new values for the masses of the W and Z particles, as recorded in the UA2 detector: the mass of the Z is 92.3 GeV (the comparable value for UA1 is 95) and that for the W is 81.5 (same for UA1).

Bannier said that there would be another proton-antiproton run in the Fall of 1985, and a 50% chance of a Spring-1986 run. After that the collider would be shut down for two years while a better antiproton accumulator, one that would provide 10 to 20 times as many antiprotons for collisions, was being installed.

John Peoples (chairman of the session) of Fermilab spoke about progress at the Tevatron, under construction at Fermilab. He said that the first proton-antiproton collisions would occur in August 1985. A year long shutdown would then follow, during which huge collision detectors would be installed. Proton-antiproton collision experiments would then begin in the fall of 1986.

Neutral Atom Trapping

William Phillips and his colleagues at the National Bureau of Standards have decelerated a beam of neutral atoms using the radiation pressure of a laser beam and “trapped” some of these atoms in an “electromagnetic bottle,” a device employing quadrupole magnets, for a second or longer. This is the first time neutral atoms have ever been trapped. In the NBS experiment a beam of neutral sodium atoms was slowed from a velocity of 1000 m/sec to about 3 m/sec, a process equivalent to cooling the atoms to a temperature of only 0.017 degrees above absolute zero.

Magnets can have a large effect on particles or atoms (ions) possessing a net electrical charge. Inhomogeneous magnetic fields can exert a force on neutral atoms if the atoms have a magnetic moment, but the size of the force is weak, making neutral-atom trapping difficult.

The trapping of neutral atoms for extended periods may make possible new measurements in the area of atomic physics, such as studies of quantum electrodynamics (QED) and even general relativity.

LETTERS

Dear Sir,

I would like to make contact between members of your Society and a Committee which I believe should be of interest to them, namely the Advisory Committee on Science and Technology to the Australian Broadcasting Corporation. I am currently Chairman of this Committee. The Committee is, in essence, an group offering advice to the A.B.C. in matters related to science and technology, particularly the programs on radio and television that fall in this area. We are also seen as a link between the Corporation and the scientific community. In order to fulfill this role we are anxious to have some feedback as to audience reaction to various scientific and technology programs. We particularly wish to obtain feedback from members of the Society and would be ready to pass on any comments that we receive in writing or by telephone.


At present it seems that the A.B.C. tends to receive letters or telephone calls from just a few particularly active listeners or viewers and so the responses may not represent a good cross section of audience attitudes. I am most anxious to encourage members of the scientific community to communicate with the Committee so that we can digest the opinions and comments and pass on such information. Naturally some people might prefer to communicate directly with the A.B.C. and we would not wish to inhibit this in any way, but apart from acting as a communication channel my Committee is anxious to inform itself of community views so that it can function still more efficiently as an Advisory Committee.

For general information the current membership of the Advisory Committee is attached.

R.D. Brown
Chairman
A.B.C. Advisory Committee
on Science & Technology

Dear Sir,

I write concerning our planned Electron Spectroscopy and Surface Science Workshop, that was scheduled for February next year.

Professor Kai Siegbahn was to be our special guest and we had planned a somewhat more extensive meeting than our usual one-day, electron spectroscopy workshop. We have recently learnt, however, that Professor Siegbahn has had to delay his visit to Australia until later in 1986; and, after lengthy discussion, we have decided to cancel, or at least delay, the meeting.

We have considered the possibility of holding the workshop as planned, but have come to the conclusion that this is likely to be less successful in view of Professor Siegbahn’s absence, the large number of other meetings being held around this time, and the possibility that we may wish to hold the workshop later in the year.

To everyone, and particularly to those who have already agreed to present papers and have given some preliminary thoughts to their contributors, we offer our most sincere apologies. We hope you will understand our decision.

John Jenkin
Chairman, RCES

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POEMS BY INGE ISRAEL

I noticed the following poems by Inge Israel published in French in “Physics in Canada”. The English translation loses some of the original elegance. If they whet your appetite, Inge has published two anthologies; Reflexions (1978), and Meme le Soleil a des taches (1980), both in Editions Saint-Germain-des-pres — Ed.

Reconstruction d’un crime
Quand Odin et ses frères
assassinèrent Ymir,
le géant primordial,
ils libérèrent
les forces fondamentales
— et son sang devint mer
sa chair se fit terre
ses os devinrent les monts
ses cheveux, la végétation
son crâne, le firmament
si grand qu’il fallait quatre nains
pour le tenir en place
car Ymir, dans sa seule carapace,
renfermait l’univers.

Sans cet ignoble assassinat
les savants d’aujourd’hui
ne se battriraient pas
pour créer une théorie unitaire
et refrayer l’unicité
dont Ymir avait joui

(les physiciens cherchent actuellement
une théorie qui puisse unifier les
quatre forces fondamentales: la
gravitation, l’électromagnétisme, la
force faible et la force forte. Les
quatre nains?)

Reconstruction of a crime
When Odin and his brothers
assassinated Ymir,
the primordial giant,
they liberated
fundamental forces
— his blood became the seas
his flesh the soil
his bones the mountains
his hair, vegetation
his skull, heaven
so large it took four dwarfs
to hold it in place
since Ymir, in his single body,
held the whole universe.

Without this ignoble assassination
present day scientists
would not struggle
for a unified theory
to recreate the oneness
Ymir had enjoyed.

(Physicists are currently seeking a theory
to unite the four fundamental forces:
gravity, electromagnetism, strong and
weak forces. The four dwarfs?)

Atlas
Atlas
idole déchu
toi qui autrefois
portais les piliers
soutenant la voûte céleste
maintenant, hélas
abattu
tu portes le globe terrestre
sur ton dos
tel, un sac
de charbon en vrac.

Energie negative
Ô Nature,
combien dur de souffrir les coups!
Pourquoi nous as-tu flanqué
cette loi selon laquelle
plus la force qui appelle un corps
est grande
plus l’énergie négative joue?
Ne vois-tu pas
combien paradoxal!
it est que plus on s’aime
plus on se fait mal?

Univers inflationniste
Une lueur minuscule
s’alluma dans le néant
Le verbe s’était fait chair
tout en ondoyant.
Et, quand il s’est découvert
il en fut si épris
qu’il se gonfla d’orgueil
et se gonfla depuis.

Inflationary universe
A tiny glimmer
ignited in a vacuum
While wriggling
the word had become flesh.

With dawning awareness
it was so charmed
it swelled with pride
and is swelling still.

Équilibre
Nos conceptions ont beau croître
et s’expand
nous ne pouvons que deviner
quel est le nombre de particules
capables de s’équilibrer
sur la pointe de l’aiguille
de la réalité.

Equilibrium
Our conceptions
may grow and swell
Still, we can only guess
at the number of particles
able to balance
on the needlepoint
of reality

Censure cosmique
Quelle chance inenvisageable
que l’horizon des événements
soit les Trous Noirs!
Leur obscurité
n’en n’est pas moins effroyable
et il faut bien se garder d’y choir
mais l’horizon des événements
les rend acceptables
comme le fait la perle
pour le grain de sable.

Cosmic Censorship
What incredible luck
that event horizons
cover Black Holes!
Their darkness is still
just as frightening
and we must take care
not to fall in
But event horizons
make them acceptable
as does the pearl
the grain of sand.

Australia pioneers B-Mac system

A new satellite transmission system will be used commercially for the first time in the world when Aussat 1 starts operating later this year.

The system, known as B-Mac, will be part of the homestead and community broadcasting satellite service (HACBSS) which will make television, radio and other communication services available to about 300,000 people in remote areas who currently receive none of these services and also to people in areas which are inadequately covered by present terrestrial means.

The B-Mac system is expected to deliver signals superior to those from the Pal-system which was adopted when color TV was introduced to Australia in 1975.

B-Mac stands for B-format multiplexed analog component.

The system was developed specifically for frequency modulated satellite transmission. Pal was originally designed only for terrestrial transmission and therefore is not optimised for satellite operation.

In the B-Mac technology a color-TV signal's luminance and chrominance components are transmitted in time-multiplexed form, thus eliminating the traditional color subcarrier needed for Pal.

This improves the chrominance signal-to-noise ratio significantly.

Chrominance signals carry the color information and luminance signals provide the light intensity information.

The term B-format means that other signals, apart from those for the color picture, are carried as integral parts of the video signal by exploiting the horizontal and vertical blanking periods which are not used for generating the picture.

The horizontal blanking period provides 6 digital 15kHz sound channels, a teletext channel and a utility data channel.

The latter will be used for information such as education material, market and agricultural reports. It will also contain a feature that will enable broadcasters to address individual customers directly.

Homestead and community broadcasting satellite service (HACBSS) equipment configuration, as recommended by the Department of Communications. A receiver set consisting of an antenna with mount, an outdoor unit, a cable and an indoor unit will cost up to $3000 depending on quantities sold and government taxes. The outdoor unit amplifies and converts the incoming B-Mac signal. The indoor unit will decode it and allow channel selection.

The indoor unit will be smaller than a standard video recorder. It will contain 3 parts — a channel selection unit, an FM demodulator and a baseband processor. It will be operated by infrared remote control.

This way it will be possible to send certain broadcasts such as teaching lessons or even weather warnings only to specific areas concerned.

The horizontal blanking period will also be used to transmit synchronising signals, whereas most of the system control signals will be transmitted in the vertical blanking period.

The B-Mac technology was developed by Scientific Atlanta of the US which in the wake of the Aussat contract is now in the process of establishing a sales and services centre in Australia.

The technology licensee in this country is Plessey Australia Pty Ltd in Sydney.

Plessey has made a number of modifications to the original system, making it more suitable for its application in Australia.

To be able to receive B-Mac signals, every homestead and community within the HACBSS range will have to install a reception set consisting of an antenna, an antenna feed, an outdoor unit, an inter-connecting cable and an indoor unit.

The complete set, which should be on the market by November, is expected to cost between $2300 and $3000 depending on the quantities sold and government taxes.

The dish-shaped antenna will have a diameter of between 1.2m and 1.8m depending on the geographical location of the installation. It will be mounted on a structure that will allow pointing adjustments.

Through the antenna feed positioned at the antenna focus the signals will enter the outdoor unit. Here the 12GHz microwave signals will be converted to an intermediate frequency, allowing lower cost circuitry techniques to be used downstream.

The outdoor unit will also amplify the signals for further processing.

The indoor unit connected with the outdoor unit via a cable will produce outputs suitable for standard electronic equipment such as TV, audio amplifier and home computer.

It will provide a means of tuning to different satellite transponders or channels and it will separate picture, sound, data and teletext information. The separation will be done by a baseband processor which will be part of the indoor unit.

The whole unit will be smaller than a standard video tape recorder.

The first test transmissions for HACBSS are planned for November and the official start of the service is likely to be on Australia Day, Jan 26.

Dietrich Georg
Engineers Australia
PHYSICS ROUNDABOUT

NEW DISPLAY FACILITY

University of Canterbury, New Zealand.

In 1984 Stephen Beuzenberg, the new demonstrations technician, and I designed a new display case to replace the tatty old one outside our Stage I lecture room. The result is shown in the diagram.

Stephen built the edifice himself last summer. The case has four bays which can be used singly or in combinations. The end two have viewing access from the side as well as the front. Red velvet curtains worthy of any Parisian bordello form backdrops and dividers. Each is hung from the ceiling using velcro so they can be shifted in seconds.

With laminated glass the display area is secure. Expensive equipment can be used. One display on crystal growth included the rubies grown by Stage III students as part of their laboratory work. A rear aisle allows for ease of mounting displays. Unsightly power supplies, etc., are hidden under the bench. Wherever possible the displays are to be interactive. Control knobs, switches, buttons, etc. are mounted on modular panels. These are vinyl covered for ease of cleaning.

The large overhang shields the displays from direct sunlight which otherwise washes out optical displays such as holograms. This overhang contains two loud speakers which can be used in stereo. At the time of writing one relays the clicks of the Barkhausen effect. Rear illuminated signs detail the category of each display.

Each bay is changed weekly although occasionally a red curtain is shifted to the front behind a "Display in Preparation" notice. 4 times 22 weeks is a lot of displays to produce. An information sheet is typed using large type mounted in a A4 size picture frame. (The golden frames go well with the curtains). The back of the frame is held in by 4 clips — to change a notice takes but a moment. Indeed the whole design of the display is to encourage rapid display change.

What sort of displays are used? Anything: lecture demonstrations that students can repeat in their own time; effects and apparatus that are too small to show large classes; displays that extend the lectures, show physics at work in the community, refresh minds about work that should be known from schooldays, honour good scientists who are past graduates, illustrate the exotic world of research, etc. There is no limit.

Display cases such as that at Canterbury are an effective way of getting physical points across to students at their own convenience. I recommend you get out the hammer and nails.

John Campbell, University of Canterbury

Monitoring of nuclear tests

Australia will soon be the first country in the world to have an International Data Centre in regular operation to monitor nuclear weapons tests — and the ANU will play an important role in the monitoring system.

Dr Desmond Ball, Head of the Strategic and Defence Studies Centre, told the ANU's recent international Conference on the Future of Arms Control that Australia's International Data Centre (IDC), based in Canberra, would be operating within two years. Other centres will be in Washington, Stockholm and Moscow.

Dr Ball said the government had given the signing of a Comprehensive Test Ban treaty 'the highest possible priority' and it was therefore pressing ahead with the establishment of a seismic National Monitoring Service (NMS) and an IDC. The IDCs would exchange seismic data, and in this way check observance of the treaty.

The importance of Australia's initiative, with which the ANU is closely associated, was stressed by Dr Ball at the conference. 'A comprehensive nuclear test ban, covering tests by all States in all environments, would probably contribute more to arms control than any other single measure,' he said.

Australia's NMS and IDC will be based in a nuclear monitoring group within the Bureau of Mineral Resources, and in January Dr Kenneth Muirhead, a Fellow in the ANU's Research School of Earth Sciences, will lead the research team within the group. Dr Brian Kenneth of RSES is already managing the seismic station at Warramunga, near Tennant Creek in the Northern Territory, which is one of the links in the NMS.

Dr Ball said the technical question of the extent to which small underground nuclear explosions can be reliably detected and identified remains the most important single issue preventing agreement on a comprehensive test ban.' However one or two authorities did believe that nuclear explosive yields as low as 1 kiloton could be detected and identified by current seismic techniques.

After the conference Mr Peter McGregor, manager of the BMR's monitoring group, said there was a good chance that Australia's NMS would be able to achieve this accuracy. It might then be possible to detect a test of even the smallest tactical weapon.

He explained that Australia had already detected nuclear explosions with larger yields at East Kazakh in the Soviet Union, Lop Nor in China and Mururoa in the Pacific. However Australia's range would be limited to about 10,000km, which put Novaya Zemlya in the Soviet Union and Nevada in the USA out of reach. It was therefore important to have IDCs in Washington, Stockholm and Moscow, as well as Canberra. They would cover the world, back each other up, and keep each other honest.

Dr Ball told the conference that Mr McGregor had been co-ordinator of an international testing exercise between 15 October and 14 December, 1984, which had involved 36 countries. About 1000 earthquakes and seven nuclear explosions had occurred during the period, and it had been established that an international data exchange regime was feasible.

Australia's NMS was already functioning, in a sense, because the BMR in Canberra had begun to receive telemeter signals from the Joint Geological and
CSIRO Sets up Women in Science Project

CSIRO has launched a national program designed to encourage more girls to consider careers in science. Announcing this today, the Minister for Education, Senator Ryan, and the Minister for Science, Mr Jones, said the low participation of women in science was of great concern.

Senator Ryan, who is also the Minister assisting the Prime Minister on the Status of Women, said: "There are potentially as many able scientists and technicians among females as among males, but far fewer girls than boys take science and mathematics subjects at school.

"We are wasting a large proportion of our intellectual resources for science, and we are failing to use the full potential of our young people," she said.

Mr Jones said the CSIRO Women in Science Project was an important step towards encouraging girls at secondary school to consider science as a desirable career choice and to continue with science subjects at school. Under the program female scientists and technical staff from CSIRO will visit schools to discuss science careers with small groups of Year 10 (16-year-old) girls.

"Schools wanting to take part in the program are sent a kit consisting of a videotape, activity sheets and suggested discussion topics for the whole class," Mr Jones said.

CSIRO, in association with the Women's Bureau of the Department of Employment and Industrial Relations, is preparing the 20 minute videotape on women and science careers.

"The kits will be used in lessons before the CSIRO speakers visit and will allow students to consider the issues of a science career and to prepare questions.

"The program started in Canberra earlier this year and coordinators have been appointed to establish it in four States. CSIRO hopes to extend the project to cover all States by early next year.

"The OECD Review of Science Policies in Australia urged the adoption of special programs designed to encourage girls to study science subjects," Mr Jones said.

"The loss of so much female science talent is a tragedy for Australia, particularly at a time when high technology industries are so important to our future."

Senator Ryan said: "The loss is also personal in terms of individual frustration and unfulfilled potential. A lack of mathematics and science training dramatically reduces career options."

"In Victoria last year, more than half of all Higher School Certificate candidates were female. However, in computer science, physics, applied and pure mathematics and the physical sciences, less than one student in three was female," she said.

The research shows that girls have effectively learnt that science is for boys before leaving primary school and their secondary schooling seems to reinforce this misconception.

"I hope that CSIRO's initiative will help to change this deplorable situation and demonstrate to many girls that they can do science subjects and choose a career in science."

For further information:
CSIRO Media Group
Ellen Peterson (062) 48 4640 (w); 48 7174 (h).

"Biggest Telescope Development Since Galileo"

by John F Webb

Scottish scientists claim they are revolutionising astronomy — by being able to produce the largest telescope mirrors without glass.

Dr Peter Waddell and Dr Bill King from Strathclyde University in Glasgow can transform a plastic sheet into a 0.6 metre telescope mirror in seconds. The result has been described as "a masterpiece of optical accuracy."

The two men have succeeded in dispensing entirely with large expensive blocks of glass needed to produce a traditional telescope mirror. All the glass does is provide smooth support for the film of silver or aluminium reflecting the image.

"Because the mirrors are flexible, the curvature can be adjusted according to the needs of the astronomer like the zoom lens of a camera. Higher curvatures for short focal lengths are needed for infra-red astronomy, while shallower curves are needed for observation by ordinary light."

Dr Waddell claims that the only restriction on the size of mirror is that of the aluminiumised plastic sheet.

At the moment the largest sheet is 1.2 metres across but already a method of welding sheets with invisible joins is being developed.

Easily and Quickly

This means that in future mirrors as large as the five metre diameter Mount Palomar telescope in the US could be made easily and quickly to standards of perfection only achieved until now after years of highly skilled work. Normally, to grind a glass mirror less than a metre in diameter would take months.

The new plastic mirrors have much greater optical accuracy and light collecting power. In terms of telescope mirrors, light collecting is about 10 times greater than the very best conventional glass mirrors.
Leading Scottish telescope maker Mr John Brainhayne has now joined the project. He admitted: "Using conventional methods, I can produce surfaces of similar quality only rarely on much smaller mirrors at much greater cost. If I don't join this project I will be put out of business. It's the biggest advance in telescope-making since Galileo."

Another advantage of the new plastic mirrors is that they do not suffer the heat problems that with traditional glass mirrors can severely limit the viewing time. Often a telescope can only work at its best for an hour or so each night when its temperature stabilizes at that of the surrounding air. By contrast the new telescopes could be used at maximum effectiveness all night long, so many times multiplying the value of observations.

A US aerospace firm is reported to have already offered large sums to gain access to the new technology.

Programme of Education in Cooperation with Industry (Epic).

by Mrs J.E. Thomas, the University of Adelaide, Department of Physics

What is EPIC?

From 1985 physics students at The University of Adelaide will have the option of completing their degree over a period of 4 years so as to include 3 periods of 4 months working in selected industries.

This idea is being practised at the moment in a number of Australian institutes of technology but in the United Kingdom and Canada there is a long history of similar university based schemes.

Why the need for EPIC, and who benefits?

In the technologically advanced countries of Europe and North America, there is a steady flow of "Pure Science" graduates at the ordinary degree, MSc., and PhD. levels into industry. In fact, competition for the best graduates is fierce. In Australia this does not happen, and as Australia struggles to gain a place in the high technology areas, it is important that it should.

The EPIC scheme is planned to be one of mutual benefit to both industry and the physics department. Industry will have the opportunity to see the benefits offered by bright young minds trained in basic physics and maths, with emphasis on formulating problems as well as solving them.

The students gain by experiencing the everyday work place and seeing how their academic training can be put to use. The University gains a system of rapid feedback as to the needs of industry and how it could adapt courses and laboratory work.

The physics department at the University of Victoria, British Columbia, Canada, has found its programme of industrial cooperation very successful. The number of students graduating in physics has increased from 3 to 5 a year in 1976, to 20 to 30 a year now. Students feel the programme teaches them how they can combine the challenges of studying pure science with the economic realities of the job market.

All students graduating from the University of Victoria programme have found jobs, and 90% of the graduates decided to do post graduate studies before entering the job market.

One interesting side effect of the programme at the University of Victoria has been a marked increase in the percentage of women participating, 15% in "Co-op" versus 1 to 2% in the regular physics programme.

Who can enter EPIC and how does the programme work?

Students who enter EPIC at the end of first year take one work term (of 3-4 months) in each of the following three years. Overseas, some work placements are made in the summer break, while other students attend courses. At present neither of these options is available here. The summer break is not as good because many companies close for a long time over Christmas and New Year. Furthermore, universities do not have the resources to duplicate courses in the summer. This has led to some formal problems over pre-requisites in third year, and we have been forced in the trial period to accept into EPIC only those students obtaining at least a credit in all first year subjects. In addition we are limited to six new students entering the program each year.

The Physics Department has compiled a list of interested companies (we would welcome any further enquiries) and students are matched with employers in a way which guarantees the greatest mutual satisfaction. The length and timing of the work terms has been decided in cooperation with representatives of local industry and the Chamber of Commerce.

During the work terms students will be paid a regular salary consistent with similar employees in the organization. Students will be eligible for TEAS payments for the terms they are at the University, subject to the normal means testing.

Students are expected to write a report on their industrial project, with copies going to the physics department and the employer. The employer also reports on a student's on the job performance. Students have to receive favourable reports from employers and a credit rating in their course work, to remain in the programme.

Possibilities for the future

Initially, job placements will be in South Australia, but the range and geographical location of placements will expand as the programme matures.

There is also planned expansion of the programme to the graduate level. This opens the possibilities of industry and the University cooperating in the formulating and funding of some more advanced research projects.

In summary, the EPIC scheme is an exciting new venture to expand the horizons of students and Australian Industry. Any queries about EPIC should be directed to

Professor A.W. Thomas,
Department of Physics,
The University of Adelaide.

Fast Reactor Costs Falling Fast

by John F. Webb

Research in Britain and other European countries has led to a "dramatic" cut in the capital cost of the next generation of nuclear power reactors known as fast reactors.

Dr Tom Marsham, a director of the UK Atomic Energy Authority (UKAEA), told a conference in
Model 2020 Ion Laser Systems

The Model 2020 Ion Laser
- Unsurpassed performance in the deep blue and ultraviolet
- Advanced technology power supply design
- Microprocessor control
- Advanced state-of-the-art plasma tube design
- Total system modularity
London that over the past two years research had enabled cost estimates for building a commercial demonstration fast reactor and supplying fuel for it to be brought down by 20 per cent. Even though it would only be a forerunner to plants of this kind it should now be able to produce power at a price competitive with present-day nuclear stations.

Although 15 fast reactors are currently in operation or under construction, including the commercial size French Super-Phenix, European nuclear organisations are still developing the technology for this new type of nuclear station which is expected to be 50 times more efficient in its use of uranium than present-day stations.

The aim is to establish three commercial demonstration fast reactors in Britain, France and Federal Germany before the end of this century. Britain hopes to start work on its demonstrator in the early 1990s so that it can be ready for operation around the turn of the century.

For Britain, its fast reactor work is the biggest single nuclear programme. It made a firm commitment to this new form of power in 1983 as a follow-on to earlier pioneering years in this field which saw the UK introduce the world's first fast reactor to produce electricity for commercial use.

Test-Bed

This was a small 15 megawatt prototype station built at Dounreay in Scotland in 1959 which was later succeeded by a larger 250 megawatt prototype plant on the same site in 1975. The latter has since become a test-bed for fuels and other components for a proposed full-sized commercial demonstration fast reactor.

The attraction of a fast reactor, which is also popularly known as a "fast breeder", is a unique characteristic that in effect enables it to produce its own plutonium fuel. Many thousands of tonnes of depleted uranium 238 remain in Britain as a result of thermal reactor operations and if this were used in fast reactors it could produce energy equivalent to more than 40,000 million tonnes of coal.

Britain has also been pioneering the technology to reprocess spent fuel from its Dounreay prototype fast reactor. It has successfully closed the cycle whereby fuel makes a round trip through the reactor, through a reprocessing plant, into a fuel-making factory and finally back to the reactor again.

As a result, the UK is planning a big reprocessing plant at Sellafield that would deal with the spent fuel from the three European demonstration reactors. This has yet to win the support of Britain's nuclear partners as well as local planning permission.

Members of A.B.C.
Science and Technology Advisory Committee

Professor Ron Brown, Professor of Chemistry, Monash University.
Dr Owen Carter, Deputy Principal, Hawkesbury Agricultural College.
Dr Keith Farrer, Scientific Consultant, Victoria.
Ms Wendy Parsons, Science Journalist, CSIRO Division of Forest Research, Parkes, A.C.T.
Dr Diana Bell, Research Fellow in Anthropology, ANU.
Dr Stuart McDonald, Srn Lecturer in Science Policy, University of Qld.

High Schools' Evening at Massey University

The staff and senior students at Massey University set up about 35 physics demonstrations for the recent biennial physics evenings for local 6th and 7th form physics pupils. On each of the two evenings, seventy five pupils and their teachers were treated to a large, colourful, sometimes noisy and always intriguing collection of physical phenomena covering many topics and spread over ten viewing areas or stations.

The pupils were divided into ten groups and viewed/interacted with five stations from 5 pm to 6.20 pm when a general halt was called for refreshment - a Kentucky Fried box each plus fruit and fluid. At 6.40 pm the show resumed to finish at 8 pm.

The comment from both teachers and pupils has been very favourable and looking over the exhibits on the morning after the night before says it can be said in all modesty, that the Massey physics staff and senior students put on a marvellous ten ten 'Physics Circus' - as Jearl Walker would say - and the pupils who attended were fortunate to have had the opportunity.

The topics addressed were:

1. Jacob's Ladder; Resonant Transformer — Spark Generator; Jumping (aluminium) Ring; Eddy Current Pendulum
2. Barkhausen Effect; TV Microscope of Magnetic Domains in YAG
3. Lego 'Bloodhound' Car — controlled by BBC Computer; Helium and elevated resonant frequencies — organ pipes/voice box
4. Ballistic Pendulum/Pellet Rifle; Projectile Cannon/Range; Rotational Motion — Rotating Platform/Spinning Bike Wheel
5. Hologram; Laser Diffraction/Interference; Newton's Rings; Wedge Gap Fringes; Strained Perspex Polarisation effects; Scattering of Sunlight
6. Heat Energy conduction in a long bar; Meteorological Data Logging; B-H Hysteresis Loop; Reverberation Time measurement
7. Robot arm/ZX81 Control; Reaction Timer; Skin
New Intelligence Test

‘Attention’ skills are a fairer guide

Research in the University of Sydney’s Department of Psychology has indicated that measuring attention may be a better way of measuring intelligence than the old written intelligence tests.

The research also has a bearing on the nature of intelligence, and shows that some aspects of intelligence decline more quickly with age than others.

A team led by Dr Lazar Stankov, Senior Lecturer in the Department of Psychology, has been investigating the role of attention as a factor of intelligence, with particular emphasis on experiments using divided attention.

In these experiments volunteers are faced with complex audio and visual tasks (such as recognising tones or responding to visual clues on a computer) at the same time.

‘In the “old days” there were paper-and-pencil tests in which you wrote down the answers to puzzles,’ Dr Stankov said.

But divided attention tests are much more demanding, as they call for more resources to be put into them and they draw out more effort.’

‘The tasks are also typical of many situations in life, such as those in which businessmen have to solve two or more problems very quickly. They are tests for such a capacity.’

Dr Stankov said the attention tests could be less ‘culturally loaded’ than the old intelligence tests, and were therefore potentially a fairer measure of intelligence. They could be used as part of job selection procedures to assess those able to cope with several things at once, and in schools in a similar way to traditional tests.

The research by Dr Stankov’s team is following earlier work which indicates there are two forms of intelligence — fluid and crystallised, a theory developed by R. Cattell and J.I. Horn in the 1960s.

‘Fluid’ intelligence is the problem solving ability that does not depend on formal education. ‘Crystallised’ intelligence depends heavily on education. Tests of attention are particularly good measures of fluid intelligence.

At the moment, Dr Stankov is studying how performance may be influenced by practising the divided attention tasks. He is also exploring the effects of prolonged training in creative thinking on intelligence.

The results suggest that both practice and training can lead to some improvement of intelligence. These effects depend on the nature of the tasks employed.

‘It is encouraging,’ he said, ‘that the effects of training, however small, can be detected with the fluid intelligence tests.’

It has been discovered that fluid intelligence declines relatively rapidly after the age of 30, but crystallised intelligence doesn’t decline until 60 or 70.

‘As people get older they are less able to perform demanding tasks, but the tasks that involve vocabulary skills don’t decline at all until the age 65-70,’ he said.

University of Sydney News

Tropical Meteorology Conference

Current research on tropical meteorology, with an emphasis on the Australian region, was discussed by more than 60 leading Australian scientists at a two-day conference in Perth during early July.

Some 30 papers were presented at the conference, covering three main topics — the Australian monsoon, tropical cyclones, and tropical analysis and forecasting.

The conference was held under the auspices of the Australian branch of the Royal Meteorology Society, with the help of the Bureau of Meteorology, the WA Institute of Technology, and Murdoch University.

Other institutions represented included Flinders University, Monash University, the University of Western Australia, the CSIRO Division of Atmospheric Research, and the Department of Defence Research Centre.

Two prominent overseas experts, Professor Takio Murakami of the University of Hawaii, and Professor William Gray of Colorado State University, took part, as did private meteorologists.

The Bureau of Meteorology also conducted its annual review of the Tropical Cyclone Warning System in Perth. The Bureau looked at the performance of the warning system in Western Australia, the Northern Territory and Queensland during 1984/85, and discussed proposals for improvements to the system for the coming cyclone season.

New body to ‘communicate’ science

Specialists in the communication of science will form the nation’s first professional body in the field, the Association of Science Communicators of Australia.

The announcement of the formation of the Association coincided with the conclusion of the ANZAAS Congress (26-30 August) at Monash University in Melbourne where the science communicators held their inaugural meeting.

The membership of the Association will embrace specialists in the communication of science through all sections of the media, including press, radio, television and publishing.

A steering committee has been elected and working parties set up in four regions to organise the activities of the Association.

‘Science’, says Dr Peter Pockley, who is acting as National Convener of the steering committee of the Association, ‘is defined by the Association as covering technology and other science-related fields, as well as basic science.’

Some distinguished scientists, active themselves in communicating science to a wide audience, attended the
inaugural meeting. It is intended to include scientists as members in order to forge closer understanding between research workers and mediators of their information and ideas.

In regional groupings the Association will run meetings which are professionally supportive for its members. The Association will foster the development of authoritative reporting, independent interpretation and skilful presentation of science through all media.

The formation of the Association will make possible the first international links between Australian science communicators and their counterparts in the Asian-Pacific region and further afield.

The Association plans to organise for its members (and, through their media, for the wider public) a national conference in August 1986, a year when there will be no ANZAAS Congress to provide a focus for public attention on science.

'The conference will offer an opportunity for leading scientists to communicate the newest information and ideas in Australian research and to comment on national policies for science and technology,' Dr Pockley says.

The University of Sydney News

Management

Australia and Italy have agreed to co-operate in a research program which will examine ways of dealing with high-level radioactive waste.

The first work undertaken will involve SYNROC and the Italian Sol-Gel process, which could lead to an improved waste immobilisation process. Italian Sol-Gel technology has the potential to simplify the SYNROC manufacturing process.

This is the third bilateral agreement concerning high-level radioactive waste in which Australia is involved. Italy joins the United Kingdom and Japan, with whom co-operation has already begun. Such co-operative agreements are one of the ways in which Australia can make a positive contribution to radioactive waste management.

The Australian Government has allocated over $4.6 million to the research and development of SYNROC. This includes $2.75 million for the construction of a non-radioactive pilot plant developed by the Australian Atomic Energy Commission at Lucas Heights, which will be used to demonstrate the feasibility of manufacturing full-sized blocks of SYNROC.

The new agreement will assist both countries in the search for improved ways of dealing with radioactive waste — an issue of international concern. I welcome this co-operative arrangement with Italy and I look forward to the contribution it will make towards realising the full potential of the SYNROC process.

Gareth Evans
Minister for Resources and Energy

The Atlas Project

ATLAS, Automatic Tester for Length and Strength, is a key step in the development of 'objective measurement' technology which is aimed at effecting considerable savings for the Australian wool industry by eliminating the necessity to display wool at the point of sale. This development is particularly significant in economic terms since few Australian industries surpass the wool industry in the value of its exports, representing some 2500 million dollars annually.

Up to 36 instruments, each performing one million tests, will be required to test the wool sold in a year. Accuracy and reliability of the instruments are of extreme importance. Two prototype instruments have been installed for routine test work in the Sydney laboratory of the Australian Wool Testing Authority Limited. Technical knowledge acquired by the Division during the developmental period is being passed on to KEL Engineering Laboratories under a legal agreement between the parties involved; the cost is being met by a grant from Wool Research Trust Funds.

ATLAS is a computer-controlled instrument for measuring the length and strength of individual wool staples. A belt holding 60 staples feeds them, one every six seconds, to the length section where each staple is conveyed at constant speed past a bank of light beams; the staple length is measured as the distance travelled by the staple while the beams are interrupted. The staple then moves on to the strength section where the ends are gripped, without slippage or damage, by two pairs of jaws. One pair of jaws moves so as to extend the staple until it breaks; the peak force during extension is recorded. The two sections of staple are then separately weighed. The sum and the ratio of the two weights are used to calculate the thickness of the staple and the position of break. Staple strength is calculated as the ratio of peak force to staple thickness. The mean and variability of each measured characteristic are calculated.

Consideration is being given to the terms under which ATLAS could be exported since it is important that the test method becomes not only an Australian standard but also a world standard for wool specification. This project is an example of the Division's involvement with both primary and secondary industry, specifically wool marketing and scientific instrument manufacture.

K J Whiteley
CSIRO Division of Textile Physics

Physics Laboratory to Test Models to NASA Orbiters

Two models of manned Orbital Transfer Vehicles (OTVs) from the US National Aeronautics and Space Administration will soon be tested in the shock tunnel of the Department of Physics in The Faculties. They arrived at the ANU three months ago and testing is expected to start in October, when the tunnel's current program is finished.

Dr John Sandeman, Reader in the Department, says the two models are both cone-shaped — one straight and the other raked, to provide lift. Other blunt models, shaped and designed to make aerobraking more effective, may also be tested later. These are models of the so-called rigid brake (mushroom-shaped) OTV and the inflatable ballute (balloon parachute) OTV.

Dr Sandeman told the ANU Reporter that the ANU’s free piston-driven shock tunnel was the only one in the world which could reproduce the highest re-entry speeds. The first two models had already been tested at Langley Aeronautics Laboratory in Virginia, but there it had been possible to subject them only to a relatively cold air flow. 'Here at ANU we can simulate the true velocity and the correct temperatures,' said Dr Sandeman.

He paid tribute to the pioneering work of Ray Stalker and Hans Hornung in the Department of Physics, noting that the tunnel was first operated in 1969. Both men had since left ANU, with Professor Stalker now heading the Department of Mechanical Engineering at
the University of Queensland and Dr Hornung now directing the Institute of Fluid Mechanics in the DFVLR, the Space Institute of the Federal Republic of Germany.

Dr Sandeman said his Department's research work for NASA had no direct connection with the US Strategic Defence Initiative, as far as he knew. He also spoke warmly of the work of his colleagues, Dr Peter Lyons and Dr Frank Houwing in the Department, and Dr Sudhir Gai and Dr John Baird in the University of NSW at Dunrobin.

He said the ANU's shock tunnel had been used in 1981 to supplement the work of the Jet Propulsion Laboratory in Pasadena, USA, which was designing vehicles for the orbit of Saturn. These had to fly through Titan's atmosphere and use this atmosphere to achieve aerobraking, in order to stay within orbit of Saturn. Correct design had doubled the practical weight of the payload.

More recently, NASA had been wanting to achieve reusable OTVs, which would be able to proceed from the shuttle's orbit to the geostationary orbit, where communication satellites are located, and then return to the shuttle. Researchers were using these OTVs for up to thirty trips would save money, a necessity for NASA, although its budget was recently increased by one per cent above the inflation rate.

Test for new industrial heating combination

The use of microwaves in conjunction with solar heated air to dry a wide range of materials is being investigated at the University of Queensland's Solar Energy Research Centre.

Dr Peter Jolly, who is in charge of the experimental work, said industrial dryers using only microwaves had been in use for 15 to 20 years. The present project was designed to improve efficiency and make the process more economical by studying the fundamental heat and mass transfer characteristics in the combined system.

In collaboration with Professor M.W. Gunn and Dr. John Ness, of MITEC (the University's Microwave Technology Development Centre), he has set up a prototype dryer that uses the same sort of elements as in the normal domestic microwave oven. Dr. Ness made up special detectors to measure the amount of energy absorbed in the material to be dried.

The material will be carried past a number of the microwave heat sources by continuous belt.

Dr. Jolly believes that by using a combined approach industrial microwave systems could be manufactured at a fraction of the existing cost, which ranges between $4000 and $10,000 per kilowatt. He is using spent brewers' yeast as a vehicle for the test program, and is collecting and analysing a mass of data relating to temperature, moisture content, and the consumption of electric energy.

Dr Jolly said the solar heated air would be supplied from a simple air heater mounted on the roof, or from a honeycomb solar pond plus heat exchanger.

The combination of hot air flow, which evaporates surface moisture, and microwaves, which penetrate into the interior of the subject material, is expected to produce a much more efficient operation.

Dr Jolly says the combined microwave/solar energy system should be effective on ceramics, brown coal, slimes from the mineral industry, various grains, seeds, fruits, pharmaceuticals, mushrooms, and industrial fireboard.

He would welcome an approach from anyone with a drying problem.

The project is being funded mainly by the National Energy Research, Development and Demonstration Council ($43,500) and the Commonwealth Employment Program ($13,500).

A major item of equipment provided by NERDDC is a fibre optic temperature probe - an instrument to measure temperatures in a microwave field.

Phone calls via domestic satellite

A remote Western Australian goldmine will have Australia's first telephone service via the domestic satellite.

Under a $200,000 agreement between Telecom and Bamboo Creek Management Pty Ltd, Telecom will establish a 6-channel customer earth-station at the mine to provide telephony, data and text facilities as part of its terrestrial network satellite service.

The Bamboo Creek earth-station will be erected in time for testing via satellite in October and is expected to be formally commissioned in January 1986.

Communications will be beamed from a 4.6m dish antenna at Bamboo Creek to the satellite and then down to Bendigo where it will join the national Telecom network.

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Conferences and Meetings

1985
Dec 2-5  10th Aust Conf on Optical Fibre Technology, Perth.
Dec 2-6  Mathematics in Industry Study Group, Sydney.
         Dr N.G. Barton, Maths and Stats CSIRO, P.O. Box 218, Lindfield NSW 2070.
Dec 2-5  4th Int. Chemical and process Engineering and Contracting Show and Conf. Singapore.
         Aust. Exhibition Services Suite 3,2 Ioura Plaza 424 St Kilda Rd Melb. 3004.
Dec 8-11  1985 Annual Conference, NZIOP*, Dunedin.
         Mr W.W. Webb, NZIOP Conf 1985, University of Otago, P.O. Box 56, Dunedin, N.Z.
         Dr S. Parthasarathy, Dept. Cryst & Biophys., University of Madras, Guindy Campus, Madras 600025, India.

1986
Jan 12-19  2nd Asia Pacific Physics Conference, Bangalore.
         Prof G.V.H. Wilson, Duntrone, phone (062) 68 8589.
Jan 15-22  International Symposium on Quantum Optics, Hamilton, NZ.
         Prof. D.F. Walls, Physics Dept., University of Waikato, Hamilton, N.Z.
         Prof. F.P. Larkins, Chem. Dept., University, G.P.O. Box 252C, Hobart, Tas. 7001.
Feb 2-8  Res. Workshop on Excited and Ionized State of Atoms and Molecules, Hobart.
         Prof F.P. Larkins, as above.
Feb 5-7  10th AIP Condensed Matter Physics Meeting, Wagga Wagga.
         Dr Trevor Finlayson, Dept of Physics, Monash University, Clayton Vic 3168.
Feb 9-11  The Structure and Reactivity of Solids and Solid Surfaces, Brisbane.
         Dr P. Smart, School of Science, Griffith University, Nathan, Qld, 4111.
Feb 10-12  4th Gaseous Electronics Meeting, Adelaide.
         Dr J. Fletcher, School of Physical Sciences, Flinders Uni., Bedford Park, SA 5042.
Feb 10-14  Sixth Conf. and Schools on X-Ray Analysis and Surface Analysis, Sydney.
         AXAAS86 Secretary, School Metallurgy, UNSW, P.O. Box 1, Kensington NSW 2033.
Feb 10-15  4th Int. Symp on Quantum Optics, Hamilton NZ.
         J.L. Bahr, Physics Dept., University of Otago, Box 56, Dunedin NZ.
Feb 11-14  Fifth Aust. Conf. on Colloids and Surfaces, Brisbane.
         Dr L.R. Fisher, CSIRO Food Research, P.O. Box 52, Northcote, NSW 2113.
         Dr S.W. Jeffrey, Div. of Fisheries Research, GPO Box 1538, Hobart 7000.
         Conf. Secretariat, Aust. Academy of Science, G.P.O. Box 783, Canberra, ACT 2601.
March  XIV Int. Congress on Glass, New Delhi.
         Dr K.P. Shivastava, Central Glass and Ceramic Research Institute, Calcutta, India.
         c/o Aust. Mineral Foundation, Corrington Street, Glenelg, SA 5065.
Jul 5-12  Int. Summer School on Crystal Growth, Edinburgh.
         Dr P.M. Dryburgh, School of Eng., Kings Buildings, Univ. of Edinburgh, Scotland EH9 3JL.
Jul 8-11  Int. Symp. on Molecules, Clusters and Networks in the Solid State, Birmingham, UK.
         Dr J.F. Gibbon, University of Birmingham.
Jul 14-18  Int. Conf. on Crystal Growth (ICCG8) York, UK.
         F.W. Ainger, Allen Clark Res. Centre, Plessey Research (Caswell) Ltd., Tewcester, Northants, NN12 8EJ, UK.
         Dr D. Tilbrook, Conf. Prog. Committee, State Conservation Centre, 7a Kintore Avenue, Adelaide, 5000.
Aug 25-29  7th World Clean Air Congress, Sydney.
         Secretary, 7th WCA Congress, GPO Box 489, Sydney, NSW 2001.
         D. Basil Briggs, Physics Department, University of Adelaide, Adelaide SA 5000.
Aug 26-29  Australian Road Research Board Meeting, Adelaide.
         Mr R.J. Memrey, ARRB, 300 Burwood Hway, Vermont South, VIC 3133.
Aug 31 - Sept 5  Int. Conf. on Raman Spectroscopy (ICORS-86), (IUPAP), Oregon.
         Prof. W.L. Petticolas, Chem. Phys. Inst., College of Arts and Sciences, 129 Science I, Univ. of Oregon, Eugene, Oregon 97403, USA.
         The Secretary, ATS, Clunies Ross House, 191 Royal Parade, Parkville, Vic. 3052.
         Meetings Officer, I.O.P., 47 Belgrave Square, London SW1X 8QX, UK.

1987
         Conf. Chairman, Future Directions Conf., RMIT, GPO Box 2476 V, Melbourne, Vic 3001.
Aug 12-20  XIV Int. Congress and General Assembly, IUG, Perth.
         Dr E.N. Master, Cryst Centre, University of WA, Nedlands, WA 6009.
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