AN AUSTRALIAN WOMAN PHYSICIST
SCIENCE CENTRES
WOMEN IN PHYSICS GROUP
EUREKA PRIZES 1993

AUSTRALIAN & NEW ZEALAND PHYSICIST
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This month's festive cover picture is by Irene Kelly.
1/21 Vale Street: The AIP’S New Business Address

November 15 was a great day for the Royal Australian Chemical Institute. It saw the opening of the Institute’s new headquarters in Vale Street, North Melbourne (within easy walking distance of Melbourne University) and the second of their now-established annual Awards Dinners.

The headquarters was opened by Dr Helen Free, the distinguished President of the American Chemical Society who was visiting Australia to attend an international conference on clinical chemistry. Dr Free was also the invited speaker at the Awards Dinner later in the day where she spoke on “Chemistry - Public Outreach in the 21st Century” in which she described the initiatives the ACS is taking to reverse negative public attitudes to science and chemistry in the US.

Last year was the 75th anniversary of the formation of the RACI and, I believe, the first occasion on which the Institute’s various annual awards were presented together. This year it was decided to repeat what was felt to have been a highly successful innovation, and from now on it will be an annual event and a highlight of the year’s activities. The occasion provides the Institute with an opportunity not only to publicize more widely within its own membership, the awards and their recipients (this year there were 10 of them) but also to reach a wider audience through its guests who included representatives of other societies, politicians, and leaders of the business community.

The AIP could well consider instituting a similar function that could honour the recipients of the Boas and Bragg Medals, the Massey Medal (in the years it is awarded in Australia), and the Pawsey Lecturer. The occasion could coincide with the biennial Congresses every second year, while in the intervening years it could rotate among the states. There would be some problems to be solved related to rules and traditions associated with each award. Nevertheless the proposal is worth considering since the advantages of the much greater impact that is possible through a combined award-giving ceremony as was so clearly evident at the RACI function.

To return to the new headquarters: the AIP has a stake although not a financial one, in the new offices. We share our business address with the RACI because, as many of you will know, much of the routine administrative business of the AIP has been carried out by the RACI staff under contract, an arrangement that has worked extremely well for many years now. Until recently the RACI operated from Clunies Ross House, along with a number of other scientific societies. The new home for the RACI provides the Institute with a higher corporate visibility, and there are advantages for the AIP too. We were invited to hold the November meetings of the Science Policy and Executive committees in the well appointed meeting rooms in the new headquarters, and it is planned to hold the annual meeting of the Council there in February also.

Members of the AIP have been warmly invited to visit the new headquarters and to meet the recently appointed Executive Officer, Dr. Susan Cumming, and her staff. We congratulate the RACI on the successful outcome of several years of planning and hard work, and look forward to the continuation of the close working relationship between the RACI and the AIP that has been of such benefit to both.

Bob Crompton

JOIN NOW

If this isn’t your copy of the ANZ physicist then you are not a member. You should join, not only to get this journal every month and find out what is happening in Australasian physics and physics education, but to support the many activities that the AIP and NZIP carry out on your behalf. Most of the work is done by people who give considerable time and effort to advance physics. But we still need funds and every new membership helps. If you are already a member, why not make an effort to recruit others?

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Membership regulations and application forms are available from: Dr A. Stain-Ross, Secretary NZIP, Department of Physics, University of Waikato, Hamilton, New Zealand. Telephone 64-7-856-2889.
The Rime of the Ancient Physicist

It was an ancient physicist
Who one day said to me
"I see from your computer screen you model in 3D.
When I was young we did not hope such wonders ere to see
For all we had was real, not virtual, reality."
I really didn't want to know
I'd heard it all before
From lecturers who rambled on about the days of yore,
Of pentode valves and slide rules and such arcane devices
And who ignored the cleverness of Tomographic slices.
I fiddled with the format
And wished he'd go away.
Alas, it was an idle hope. I saw he meant to stay.
"When I was young", he murmured, on reminiscence bent,
"I hankered not for fame nor gold but to experiment.
"The lad is bright", my teachers said,
"And quite good at debate.
You should enrol him in the law at which he'd be first rate,
He'd earn a damn good living with the muscles of his jaw.
He won't make money out of science, as you have heard before."
But I was young and waterproof
And had made up my mind
That to the law I never was sufficiently inclined.
I did enjoy in argument to see opinions swayed,
But what was that compared with how the universe was made."
He told me about where he'd been
And all the things he'd done
"The pay was marginal" he said, "But, by God, it was fun.
We were a bit like amateurs, there to enjoy the game.
It mattered less who won or lost, the physics was the same."
"How could you be such dilettantes?
And let your science serve
The evil ends of powerful men, out to control the world.
The young are more responsible. We worry about things
Like, will the earth be boiling hot and balanced Yangs and Yins.
We are now more professional
In how our labs are run
And who would fund a grant if told 'I'm doing it for fun'?
There is nothing wrong, of course, with feelings of elation,
Provided that they do not harm our score in the citations."
"I saw upon a gravestone once,"
He smiled and looked at me,
"As you are now so once was I, as I am now you'll be.
I thought perhaps it might be true, when first I came in here."
Then at the door he paused and said "A Happier New Year."

Jak Kelly

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Pulsars and Relativity

October Lecture by
Dr. Richard N. Manchester given
on the occasion of the award of the
1993 Nobel Prize for Physics to
Russell Hulse and Joseph Taylor

It is now a long tradition of the
Victorian Branch, that the October
meeting be devoted to a presentation of
the work of the current year's Nobel
Laureates. As the Nobel Laureates are at
that stage of only two weeks standing,
this places enormous demands on the
Branch Committee and the Speaker.

This year's Nobel prize was given to
Russell Hulse and Joseph Taylor of
Princeton University for their discovery
and analysis of the binary pulsar PSR
1913+16. Their observations of PSR
1913+16 have done more to rigorously
confirm Einstein's general theory of
relativity than all the work of the last 80
years. The presentation was given by
Richard Manchester, Chief Research
Scientist, CSIRO, Australia Telescope
National Facility. No better choice of
speaker could have been possible.

Manchester is himself a world leader,
whose group has discovered most of the
known pulsars. He is a coworker with
Joe Taylor on pulsars and co-author
with him on the definitive treatise
"Pulsars" (Freeman, 1977), whose 2nd
edition is about to appear.

Why did Hulse and Taylor get the Nobel
Prize? The pulsar PSR 1913+16 consists
of two neutron stars of almost equal mass
in orbit around each other with a
period (year) of about 8 hours. One of
the neutron stars is a millisecond pulsar
of especially stable period, which acts
as an orbiting clock. Hulse and Taylor
analysed the pulse arrival times to
phenomenal accuracy. This time series
depends on many things. The Doppler
shift due to the motion of the pulsar, the
Earth, the Sun, and the Sun in the
Galaxy. It depends on the gravitational
fields, in the pulsar, in the Galaxy and
in the Solar system. To comprehend the
precision of Hulse and Taylor's data,
Manchester quoted their determination
of the pulsar's proper period as
\[ P_0 = 1.557\,806\,448\,872\,75 \text{ msec i.e.} \]
\[ 1/10^4 \text{ accuracy.} \]

With such phenomenal precision and the
extremely relativistic nature of the
pulsar, the manifold predictions
of Einstein's general theory of relativity
are capable of stringent test. From the
determination of the Keplerian and
post-Keplerian parameters of the binary
pulsar from the timing data many
aspects of general relativity have been
verified. These include:

- the advance of the periastron of
some 4° per year, (rather than the
advance of the perihelion of
mercury by 43° per century.)

- the Shapiro time delay of the pulses
as they pass the pulsar's companion
neutron star. In fact, GM/c^2R , the
parameter which controls this
delay, is 0.2. This value is so large
(the corresponding value for the
solar system is \(2 \times 10^{-6}\)) that

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AIP & NZIP NEWS

Linearised relativity is inadequate. That is really new.

- gravitational radiation which is a prediction of Einstein’s theory. The loss of energy due to this radiation is expected to reduce the radius and hence the period of the orbit on each revolution. Richard Manchester showed us a graph of the progressive change with time of the orbital phase predicted by gravitational wave damping theory. The large number of observed points exactly fell on the graph. It is now very hard to doubt the existence of gravity waves.

Although not impinging directly on general relativity, the timing data have also enabled the mass of the pulsar 1.4409 ± 0.0012 times the mass of the sun and its companion 1.3875 ± 0.0012 times the mass of the sun, to be found with extreme precision, a first in astronomy.

In addition to the review of PSR 1913+16, Manchester discussed other binary pulsars, and pulsars with planetary systems.

In short, Dick Manchester gave a rewarding, scholarly talk to a large and appreciative audience.

Geoffrey Opat
University of Melbourne

November Meeting
Boas Medal Winner

The Boas Medal is presented every year to a scientist resident in Australia, for original research making the most important contribution to physics based on papers and work in the preceding four years. The medal honours Walter Boas, who was Chief of the CSIRO Division of Tricphysics and a lecturer of solid state physics at the University of Melbourne. Walter Boas pioneered work on the deformation of single crystals and was devoted to the AIP, being a Foundation Fellow when the AIP was formed. The Boas Medal was presented at the November meeting of the Victorian Branch of the AIP held on 11th of November to Professor James Williams, Head of the Department of Electronic Materials Engineering in the Research School of Physical Sciences and Engineering at the Australian National University. The Medal was awarded for Professor William’s contributions to the fields of materials modification and semiconductor processing, especially in relation to the understanding of ion-solid interactions and applications to materials characterisation and modification. After accepting the medal Professor Williams presented a lecture titled “Ion Beams: Indispensable Tools in Solid State Science and Technology”.

Boas Lecture

The thrust of Professor William’s work has been to obtain physical understanding and insight into engineering processes. He has been involved with ion-beams both as a probe and as a technological tool. The lecture presented work on defects in silicon produced by ion-beams. Ion-beams are used in many different applications. Ion-beams can be used for analysis of materials to give information on composition, structure, foreign atom location and structural damage. Ion-beams are also used for materials modification especially in integrated circuit technology where they are used for doping, etching, the removal of defects, forming buried insulating barriers and for sputtering and deposition. As an example there are 57 ion-beam processes used in the 400 process steps to produce a MOS chip. Ion-beam techniques are currently being used to reduce the scale of metal-oxide gates to 100 nm, with oxide layers of 4.5 nm. Ion-beams are also used for modifying surface properties such as hardness, corrosion resistance, magnetic, chemical and optical properties and superconductivity.

High energy ions, up to many MeV, cause massive displacements within solids that may be permanent. For instance, one 100 keV arsenic ion can displace up to 900 silicon atoms. This damage of the crystal structure produces large amorphous regions of material. Heat treatments restore the crystal leading to a sharp boundary between the restored structure and a thin amorphous layer. High energy ions are also used to implant material into solids under non-equilibrium conditions. This technique can produce novel materials with concentration of implanted atoms many times greater than the equilibrium solubility limit of the atoms. However, the defects in the silicon caused by the high energy ions can be very detrimental to the electronic characteristics of devices fabricated using ions. The formation of these defects needs to be understood so that they can either be avoided or removed from the active region of electronic devices.

The defects produced by high energy ions can initially be considered as either simple vacancy or interstitial defects. Single vacancy defects can carry either positive, negative or neutral charges and are stable in silicon below 180°C. Two single defects can join to form a divacancy which may be considered as being stable up to 250°C - 300°C. Multi-vacancies are less stable than the di-vacancies and so dissociate back to di-vacancies. Thus no voids or vacancy loops are observed in silicon after bombardment with high energy ions. Single interstitial defects in silicon are extremely mobile and will either move rapidly to a free surface or to some other pinning structure in the solid. No interstitial defects have ever been observed in silicon. Interstitials may also form more complicated extended defects involving 10 to 15 atoms to accommodate the lattice distortion. These extended defects require high energies to move and no defects are observed in ion-bombarded silicon annealed at 600°C. However, interstitial loops are observed if the annealing temperature is increased to 900°C since enough energy is now available for the complex defect to move and coalesce. Such loops are detrimental to the electronic properties of small devices. Ion-beams not only induce defects in solids but can be used to control the distribution of defects in the solid.

High energy ions cause damage at depth, with little damage near the surface. For instance, 6 MeV boron implanted into silicon gives a maximum defect density of 7 microns into the solid. Also, the amount of damage peaks at a certain ion current and reduces with higher current. This is due to the annealing of single vacancy defects, produced by one ion, before they can form divacancies by the highly mobile interstitial defects produced by another ion. This reduces both the number of divacancies and the number of single interstitials available to form complex, extended interstitial defects. Defects can also be moved deeper into a material and away from regions where they will affect device properties. This is achieved by irradiation with higher energy ions which break up the complex, extended interstitials to form the highly mobile single interstitial defects. These are then free to move away from the region where they were formed.

Ion-beams produce amorphous layers of material due to the displacement of atoms from the crystal lattice. This amorphous layer can be reduced by heat treatment, however ion-beams can also be used. The reduction or formation of the amorphous layer depends on the temperature of the silicon that is being ion-bombarded. At higher temperatures the amorphous layer can be reduced while at lower temperatures it can be grown. At higher temperature, the
formation of vacancies at the interface allows recrystallization to take place. This is observed to occur at a lower energy of vacancy formation than that required in the solid crystal and indicates that the energy for vacancy formation at an interface is lower than the energy within the crystal structure.

Ion-beams can also be used to remove impurities in material. The defects formed deep in the solid act to getter the impurities. The best defects for gettering metal impurities appear to be voids. An example is the use of voids, around 10 atomic lattices in diameter, formed by hydrogen bubbles in silicon which trap copper that has been deposited on the surface of the silicon. This is useful for device fabrication where impurity concentrations of better than 1 part in $10^{12}$ are required.

In summary, ion-beams are an important tool to probe fundamental processes in physics. They have been used to gain a better understanding of the use of ion-beams in semiconductor technology. Ion-beams have an intrinsic problem due to the disorder and damage they introduce to semiconductor devices. A better understanding of the effects of high energy ions on the structure of silicon leads to methods, using ion-beams, to either reduce or remove this damage or to use it in other ways to improve the electronic characteristics of devices.

In opening the meeting, Branch Chairman Stewart Campbell referred to the long standing link between Dr Pawsey and the ACT Branch in that it was Joe Pawsey himself who delivered the address at the inaugural meeting of the branch in 1960. Dr Campbell then welcomed Dr Pawsey’s son Hastings and wife Elizabeth to the Memorial Lecture.

Dr Whiteoak spoke on a most topical subject, having chosen as his title “The Missing Cosmic Matter Mystery: there’s more out there than meets the eye!”. He began by mentioning his association with Dr Pawsey in 1962 in the successful search for linearly polarised radio sources using the (then) new Parkes dish and went on to give a radioastronomer's view of the missing mass problem. Dr Whiteoak emphasised the utility of the Compact Array of the Australia Telescope in imaging the neutral hydrogen velocity structure of southern galaxies - a vital link in establishing a quantitative measure of the mass deficit in galaxies. He informed an attentive audience of the order of magnitude discrepancy between the “gravitational” mass as deduced from such dynamical observations and the much smaller luminous mass deduced from radiometric and photometric observations. Dr Whiteoak went on to speculate on the nature of the missing “dark matter” mentioning both MACHOS (Massive Astrophysical Compact Halo Objects) and Big Bang remnant WIMPS (Weakly Interacting Massive Particles) as candidates.

The recent well publicised MACHO discovery at Mt Stromlo and elsewhere of dark matter in the form of compact galactic halo objects, thought to be brown dwarfs, naturally received the speaker’s attention. It was pointed out that their detection, by way of the transient photometric brightening of more distant star light by gravitational focussing was an interesting extension of gravitational lensing by galaxies suggested by Zwicky in 1938. Gravitational lensing by massive dark objects, the basis of a well known cosmological example of “delayed choice” in quantum optics used by Wheeler to illustrate his concept of retroaction, had also been invoked to successfully account for the observation of closely spaced pairs of identical quasar sources in recent years.

In concluding, Dr Whiteoak suggested that while the reality of the Great Dark Matter Mystery was firmly established, its final resolution would require the combined efforts of astronomers and astrophysicists for some time to come. He expressed his expectation that the collaborative studies made possible by the award of the Max Planck Prize would contribute significantly to that resolution.

Paul Edwards
University of Canberra

VIC

1993 Pawsey Memorial Lecture

The 1993 Pawsey Memorial Lecture was delivered by Dr John Whiteoak, Deputy Director of the Australia Telescope, in the Manning Clark Lecture Theatre at the Australian National University on October 19. Dr Whiteoak recently shared with Professor Richard Wielebinski of the Max Planck Institute for Radioastronomy the prestigious Max Planck Society Research Prize for the promotion of collaborative studies in radioastronomy.

John Whiteoak is the fourth Pawsey Lecturer to address the ACT Branch. He follows Dr Bob Frater in 1983, John Bolton in 1975 and Sir Richard Wooley in 1969.

AUSTRALIAN INSTITUTE OF PHYSICS

31st ANNUAL GENERAL MEETING
To be held at 1/21 Yale Street, North Melbourne VIC 3051
12.30pm 24th February 1994

AGENDA

1 Apologies, recording of proxies.
2 Minutes of the 30th meeting.
3 Business arising from the minutes.
4 President’s report.
5 Treasurer’s report.
6 Appointment of Auditors.
7 Any other business.

John Riley
Honorary Secretary
David Allen receives his Eureka prize from Robin Williams, ABC Radio Science Show, watched by Karina Kelly of the ABC Quantum Program.

The Eureka prizes were established four years ago by the Australian Museum, POL and the ABC. Five are awarded annually for the Promotion of Science, for Environmental Research, for Environmental Journalism, for a Science Book and an Industrial prize. The value of the prizes has been increased to an annual total of $40,000, divided equally amongst the first four awards, with the addition of support from UNSW Press, DEET (Department of Employment, Education and Training), and DEST (Department of Environment, Sport and Territories). Amongst the many high calibre people and organisations, physicists feature regularly in the nominations, particularly for the first and fourth of these categories. Last year, for example, Paul Davies of Adelaide University was awarded the book prize for, "The Mind of God", and Michael Gore and Questacon (National Science & Technology Centre) got the Science Promotion prize. This year's presentation, was held as usual at the Australian Museum in Sydney and televised live as an ABC TV Quantum program on October 27. We would like to congratulate David Allen of the Anglo Australian Observatory for taking out the ABC Eureka Promotion of Science prize. The specification for this prize is: "For making science and the results of scientific research known and understood by a broader public, or for raising public awareness of the excitement of scientific discovery and its contribution to solving many of the problems facing society. The prize is not open to professional journalists but to people working within science". Those familiar with David Allen's activities and work will agree that the panel of judges made an excellent decision.
The Exception to the Rule
THE CAREER OF
AN AUSTRALIAN WOMAN PHYSICIST

NESSY ALLEN

Even today schoolgirls do not often choose physics as a subject to study nor do they often contemplate it as a career. Yet before the second world war there were a few Australian girls who found it fascinating and who never thought of any other possibility. Some made major contributions to the advancement of knowledge and were highly regarded by their peers both in this country and overseas, though their names are unknown both to the general public and to historians of science. One of these rare women was Jean Laby, who became virtually the sole woman atmospheric physicist of her generation in Australia.

This article on Laby's life and work arises from a major project I am undertaking on Australian women scientists who were active during and after the war, concentrating at present on those who have retired and who are available to be interviewed. Its aim is to examine the institutional restraints and social attitudes faced by women scientists of this era in an Australian context and, when the project is complete, to locate them within the framework of the Australian scientific community of their period. The study will also serve to enhance recognition of women whose contributions have helped the advance of science and to clarify their achievements. In response to the recently stated need for more 'empirical data on the relations between women and science in precisely delineated historical and sociopolitical contexts', the project attempts to provide such data for Australian women scientists active in the post-war period, not only on conditions of employment, opportunities, difficulties and so on, but also the scientists' own view of their experiences.

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An earlier version of this paper was presented at the Seventh International Conference on Gender and Science and Technology (GASAT) in Waterloo, Canada July 1993, and appears in the proceedings, Haggerty S. and Holmes A. (eds) "Transforming Science and Technology: Our Future Depends on it; Contributions to the Seventh International GASAT Conference", 31 July-5 August 1993, 1:407-416 (1993)

Jean Laby was born in Melbourne in 1915, the elder of two girls. Her career path was almost preordained. Her father, T.H. Laby, was Professor of Physics at Melbourne University for many years and one of the most important and most highly respected figures in the physics community of Australia before the war. Born in Creswick, Victoria, he had trained at the Cavendish Laboratory in Cambridge - one of the first Australians to do so - and one of the very few to return to their homeland to work. After holding the Chair in Wellington, New Zealand, for six years, he accepted the Chair in Melbourne in 1915. He was unusual at this time in believing that university academics should undertake research. In Melbourne he established what was probably the strongest university research school in the southern hemisphere. One historian of science has stated that
Jean Laby (School of Physics, the University of Melbourne) at a microscope used to examine nuclear emulsion plates for cosmic ray research in about 1957.

'Physics became a profession in Australia in the late '20s or early '30s of this century'. Laby helped to bring this about. He initiated radio research in Australia and was subsequently elected a Fellow of the Royal Society.

Daughters do not necessarily follow in their fathers footsteps. But from infancy Jean Laby breathed the atmosphere of physics - 'that was the topic around the house'. At home, she lived in the grounds of Melbourne University for most of her childhood. Abroad, when the family was in England, they were in close contact with leading scientists of the day, including the Rutherfords, with whom they sometimes stayed.

She was interested in physics. One of her earliest memories is of her father on walks in the Melbourne Botanical Gardens teaching her about refraction by putting his walking stick in a pond to show her how the stick appeared to bend. Her education was excellent.

Radar for tracking balloons launched from Mildura. Wind finding flights were made several days prior to a scientific flight. These wind patterns were used to predict the suitability of the conditions for impending scientific flights, in this case for an infrared telescope from Japan in 1979.
THE EXCEPTION TO THE RULE: THE CAREER OF AN AUSTRALIAN WOMAN

Professor Laby saw it that she went to one of the few girls' schools in Melbourne which taught science to matriculation level; on the staff were some first rate teachers, including one of his MSc students.

For a time attracted to architecture, she finally decided to concentrate on mathematics at university despite the fact that she disliked being known as her famous father's daughter: "I hated going to his lectures". Nevertheless she was one of the very few women students of her era who majored in physics at the University of Melbourne, graduating in 1940. (This was one year later than her fellows because her studies were interrupted by a stay in England for one of her father's sabbaticals. During that year she attended some of Rutherford's lectures at the Royal Institution.)

The war years created a demand for physicists in research and teaching posts, though there were not yet many qualified women. Laby was not sure what to do after her graduation and her father seemed unwilling to help her, telling her that she was now on her own. She found herself a job with the Bureau of Meteorology in Melbourne - an organisation with which she would have a great deal of contact later in her career but she never actually took up her appointment. As the young men in the universities joined the services, departmental heads found themselves short of staff and Professor Laby had to employ several women physics graduates as temporary demonstrators in the Department of Natural Philosophy. His daughter was one of them.

Some of the women stayed on at the University after the war. "They were not encouraged, however, to undertake advanced work, and all remained in junior positions in their department until close to retirement age." Laby was an exception in being appointed to a lectureship in 1958 and promoted to senior lecturer in 1961. She retired in 1980 after 41 years at the University.

When Professor Laby was forced to retire in 1944 because of ill health, her daughter decided that she would like to become involved in research. In those days, a demonstrator had to apply for special permission to undertake any research, and hitherto, feeling that perhaps she lacked the necessary prerequisites, she had been reluctant to embarrass her father by applying to him. Now, however, she was granted it. She started work on the measurement of thermal conductivity, a research interest within the department and was awarded her Master's degree in 1951.

She was invited by a staff member, Dr V.D. Hopper, to join the cosmic ray group with a particular interest in high energy collisions. She had known Hopper, who was about her age, for many years, as he had been one of her father's students and later his collaborator. In fact he had at times been a welcome addition to the family, when he accompanied them over Christmas vacations to work on a new edition of Kaye and Laby's Tables of Chemical and Physical Constants, in which Jean Laby also assisted.

In the course of this research she began her association with balloons. They exposed nuclear emulsions high in the atmosphere. They flew stacks of emulsions on meteorological type balloons modified to remain at high altitude for long periods. Aircraft had already flown cosmic ray plates above 7.6 km and the objective was to send them higher on balloon flights, compare results at different altitudes and make a detailed assessment of this method of studying high energy particles. By 1952 they achieved unprecedented results through the development of a valve mechanism which activated when the balloon reached a pre-set diameter; they attained heights above 24 km for flights of more than 3 hours, and reached 38 km the following year. The Commonwealth Meteorological Bureau and the Department of Supply became interested in the project and provided help. They too were soon using balloons fitted with the new valves.

1957-8 was International Geophysical Year and so the group, which had been publishing both in and outside Australia, concentrated on intensive field work. Cosmic ray photographic plates were successfully recovered and were analysed for heavy primary interactions. Balloon flights using the valves in relatively inexpensive meteorological balloons provided data to greater heights in the stratosphere than previously. The team reported that now 50% of their flights reached altitudes exceeding 33.5 km and 30% over 36.5 km, and that "a valuable set of information is being accumulated." Later their balloons reached 40.8 km.

The importance of this research can be gauged by the fact that by 1956 the Nuffield Foundation had made two grants totalling £3,000. The work gradually caught the public imagination and the Melbourne Age published an article, "Balloons Unlock Secrets of Upper Atmosphere" describing the project in some detail. A further £5,000 was received from Nuffield in 1959 to extend the work in South Africa and South America.

Laby went to South Africa for about 8 months during her sabbatical leave for this purpose. She wished to go to South America too but was prevented from doing so. The new Head of Department, whose interests were in a different area, seems to have disapproved. He was, in addition, not favourably inclined either towards women or towards Laby. Whatever the reason, she was forced to return to Australia.

Dr L.H. Martin, who had studied under and worked with Laby's father, had been invited to accept the Chair of Physics when Laby retired. He had been very active in defence work during the war and was mainly responsible for the establishment at Point Cook some 30 kilometres from Melbourne, in 1961 of the Royal Australian Air force Academy as an affiliated college of the University of Melbourne. Hopper was appointed Professor of Physics and Dean of University Studies and promptly invited Laby to join him. Until she retired she was the only female academic member of staff in the department.

At Point Cook she continued her research on measurement of cosmic radiation, working also on projects to do with radar meteorology, balloon-borne cameras, and stabilised airborne repeaters. Stratospheric wind measurements began at Laverton, Victoria, where a continuous flight program was carried out throughout the year. Meteorological stations in outlying locations in other States were also used for about four series of flights a year, necessitating considerable travel over wide areas of the country. Longreach in Western Queensland, for example, was particularly remote and difficult to visit. These studies and other upper altitude wind investigations attracted the attention of the US Atomic Energy Commission which in 1966 awarded Laby a contract of $A100,000 over several years for stratospheric wind measurements.
studies over Australia. During this period, "The Melbourne Sun" reported on the project under the heading 'They Reach for the Sky'.

One of the objectives of the project was to establish whether there was a transfer of air between the two hemispheres over the equator. It is of course easy to see the military implications of this kind of work. Much of it was done at the time when nuclear testing was being carried out above ground and information was needed on how far and in what directions radioactive material could travel. Laby herself however, was never involved in any classified works. She was concerned only with supplying wind data.

In 1972 she became involved in the Climatic Impact Assessment Program of the US Department of Transportation, which was funded by the US Office of Naval Research. Part of this global study relating to stratospheric aerosol particles was undertaken by the University of Wyoming. The Australian section of the project supplied southern hemisphere data used in an assessment program of the effects of supersonic transport on the stratosphere. Laby carried out the experimental work, at first with a graduate student, and then on her own, sampling the atmosphere up to the lower stratosphere (about 30 km altitude). Two sizes of aerosol particles, ozone, water vapour, temperature, pressure and winds were measured. Analysis of the data was then made by Laby and the researchers at the University of Wyoming at Laramie, where she spent two study leave periods and a number of shorter visits.

During 1974 she carried out a short research program on the effectiveness of a sensor used to measure small traces of water vapour in the stratosphere. Her work was spent working mainly on the 'dustsonde' aerosol measuring instrument. The method gave a direct in situ measurement of two sizes of aerosol (larger than 0.3 and 0.5 micrometer diameter); the results were telemetered back from the balloon in flight. Such direct measurements were particularly important in the southern hemisphere where hitherto there had been little information on stratospheric aerosol.

Subsequently, a number of dustsondes were maintained and calibrated in Melbourne. This necessitated research into methods and means suitable to this locality, so that flight data from instruments flown in Australia would be comparable with those calibrated and flown by the University of Wyoming group. Laby worked on this and other associated problems during her study leave in 1978, spent once more at the University of Wyoming.

In 1975 she was awarded a US$25,000 contract by the US Office of Naval Research, in collaboration with the Division of Cloud Physics to measure southern hemisphere stratospheric aerosol. The CSIRO group had developed a different method of measurement from the 'Wyoming dustsonde'. This study gave both unique data on the stratospheric aerosol and a valuable cross check of the validity of the two techniques, one using in situ light scatter and the other electron microscope analysis of collected particles. For the first time it was demonstrated that the two methods were in fact in agreement.

Analysis of the southern hemisphere aerosol data also provided interesting and unique information on atmospheric circulation, particularly of inter-hemisphere transport. Volcanic eruptions provide an injection of material into the stratosphere. When this was detected, deductions could be made about stratosphere transport methods. This information was applied to the exhaust gases of supersonic aircraft and an estimate made of their residency time and their trajectory. The data obtained from Laby's studies of the southern hemisphere stratospheric aerosol were combined with those of the northern hemisphere. Together they showed that between volcanic eruptions the stratospheric aerosol did not disappear but slowly subsided to an equilibrium or 'background' level. Laby continued this work until her retirement in 1980, studying particle sizes and their vertical distribution to an altitude of 30 kilometres.

The field work in which she was engaged throughout her career was physically very demanding. It involved the handling of large and heavy gas cylinders, unwieldy balloons ranging from 3 to 6 metres in diameter on the ground, and often fragile payloads. It also required long hours depending on the weather, and strenuous travelling, both to reach the weather stations and to follow the balloons by truck.

Research students were often involved in the field trips but Laby was responsible for the planning and on-site supervision of the flights. Slightly built, with a delicate physique, she was the only woman in all her projects and she felt people thought that it was more sort of rather odd - a woman not only doing physics but flying huge balloons.

Laby worked at a time when women scientists were the exception rather than the rule. Discrimination, not always overt, could hamstring their career then, just as it can now. Even in 1983 a Report on discrimination against women in CSIRO found that women scientists were promoted less frequently than men and to lower positions. Laby claims that she never experienced any discrimination. But the listener to her story notices a number of instances which, although they may not be considered outright discrimination, nevertheless give an indication of the stoicism of a woman who has had to deal with many of these uncomfortable situations. For example, as an undergraduate she enrolled in architectural drawing. She was the only girl in the class and was ignored by the lecturer to the extent that although there was a roll call at every lecture her name was never called. She found the situation so uncomfortable that she withdrew from the course. There were other instances. The accommodation she was given at Point Cook was superior. She had a wardrobe with a special place for her sword! The all male classes often said 'Good morning, Sir' as she entered the lecture room! Many times at meetings, attention was inadvertently focussed on her presence by the chairman saying, "Lady and Gentlemen.........' and she stopped going to 'Dining-In' nights when she found that the Matron of the Hospital also had to be invited. These are perhaps small things in themselves but to a sensitive woman they can become an ordeal.

It seems to me, moreover, that Laby was certainly discriminated against in that she was never promoted beyond the rank of senior lecturer. She published in world class journals, she worked with first rate physicists, she attracted large sums of money for research projects. According to Dr John Gras, now Principal Research Scientist in the Division of Atmospheric Research, CSIRO, she did 'world class work'. Yet though she applied for a readership, she was not granted it and was not even given reasons for the refusal. Dr Gras, who was one of her Ph.D students, says that he felt she was always battling because she was a woman. He says that
in those days 'women scientists were not really treated as equals - there was no level playing field'.

It appears that she was also excluded from the informal, scientific, male networks operating at the University of Melbourne, although this may not have been deliberate. (The importance of such networks and the effect on women scientists when they are excluded has now been well documented.) Laby tended to keep to herself but she did notice that there was definitely an 'in group' from which she was excluded. On the other hand, the position of staff recruited to the Point Cook Academy was becoming difficult. Technically they were still members of the University and were expected to spend some time there. This meant commuting from one campus to the other, then a journey of some forty minutes. The working hours kept by the Academy and the University were quite incompatible, somewhat hindering communication between the staff of the two places, and it is possible that this circumstance contributed to the feeling that she was not accepted by her male colleagues.

Laby's work situation became tenuous in another respect, although this had nothing to do with the fact that she was a woman. The Academy had not long been set up when rumours began to circulate that it was to be closed. Although this in fact only eventuated after Laby's retirement, the atmosphere at the Academy gradually deteriorated. Staff naturally began to look for other positions and the department was not permitted to appoint any additional staff. A large research school was nevertheless built up, but it became more and more difficult to attract postgraduate students since no one could guarantee that the Academy would still be operating for the term of their studies. Altogether the atmosphere was insecure and not conducive to sustained research, but Laby carried on with her work despite the uncertainties of the situation.

Although she was never ambitious, nor driven by the devil of egotism, she would have liked to have her work acknowledged by being promoted. She has enjoyed her life though she is not entirely sure that she would pursue the same path if she had to live all over again. Her greatest regret is that she was not a more effective lecturer. It was not the preparation of the material that she disliked. She was never able to overcome her nervousness at facing a lecture hall full of students and much preferred teaching them their practical work. Best of all, she loved her research, particularly the later studies connected with the University of Wyoming. That her work with the research group there was appreciated is confirmed by the fact that she is still in contact with those who were involved and with some of the CSIRO people with whom she collaborated. At least she has the satisfaction of knowing that there has been peer recognition of her work outside her institution if not so much within it.

Jean Laby is representative of those women scientists who achieved much during the post-war period without winning public acclaim. Many of the rapid technological advances set in motion by the exigencies of war demanded a greater knowledge of the environment for their successful implementation. Laby worked in an unusual corner of a discipline generally considered to be the province of men; tribute should be paid to her as a woman who achieved distinction among her peers despite challenges to her confidence and self-esteem. In the quest for knowledge she was prepared to rough it and to endure physical hardships with little reward. She commands our respect and the value of her contribution in atmospheric physics should be acknowledged.

References


7 From an interview with Jean Laby. Unless otherwise stated, all the statements made by Jean Laby are from interviews conducted by the author.


10 *The Melbourne Age*, 23 April 1959.

11 *The Melbourne Sun*, 1 October 1968.


13 Stated by Dr John Gras, Principal Research Scientist in the Division of Atmospheric Research, CSIRO, in a personal communication to the author, October 1992.

A science centre is a place where the public can go to learn in a very direct, practical interactive way about science. Because of their relative ease of maintenance most such exhibits are presently of a physics nature. The idea behind these centres can be summarized by the Chinese proverb:

"TO READ IS TO FORGET. TO SEE IS TO REMEMBER. TO DO IS TO UNDERSTAND."

In recent years there has been a steady increase in the number of such centres. Presently there are twelve in Australia. An excellent article about the promotion of science through the operation of such centres has been written recently by Robin Lendon [Search 23 (1992) 311] of the National Science and Technology Centre in Canberra. The writer has had the good fortune to visit half the Australia centres and one in Hong Kong. It is not the purpose of this article to review or compare these centres with each other but to draw attention to specific exhibits which are popular with the public, educational, and easy to duplicate so that those who may not have the opportunity to visit these centres elsewhere and have the job of mounting new exhibits can gain new ideas. If you are visiting any of the cities listed below, the centres are well worth seeing.

Some centres have substantial collections of static displays such as complete aeroplanes, parts of space craft, old trams and so on. We will concentrate here however, on exhibits with which visitors can have direct hands-on experience.

The centres visited are:
The Powerhouse Museum in Sydney
300 Harris Street, Sydney NSW - phone (06) 270 2800
The Science Centre at the University of Wollongong
University of Wollongong, Wollongong NSW - phone (042) 836 665
The National Science and Technology Centre in Canberra
King Edward Terrace, Canberra ACT - phone (06) 270 2800
The Scienceworks Museum in Melbourne
2 Booker Street, Spotswood, Melbourne VIC - phone (03) 392 4800
The Queen Victoria Museum in Launceston
Wellington Street, Launceston TAS - phone (003) 316 777
The Investigator in Adelaide
Rose Terrace, Wayville, Adelaide SA - phone (08) 410 1115
The Hong Kong Science Museum
2 Science Museum Rd., Tsimshatsui East, HK - phone HK 732 3232.

The Powerhouse Museum

The splendid Powerhouse Museum in Sydney, located near Darling Harbour, is housed in a complicated building which was once a powerhouse. The number of hands-on exhibits is small. This is no criticism of the museum which does not set out to be a totally interactive science centre.

Most of the hands-on exhibits are mostly located together on one of the lower floors. Photography by the public is not allowed in this museum so word descriptions must suffice here.

There is a nice exhibit showing the magnetic field associated with a solenoid. A series of small compass needles is mounted near the solenoid. When an electric current controlled by the public is passed through the solenoid these orientate along the lines of the magnetic force. Reversing the current causes these small needles to reverse their direction.

A powerful angled Bernoulli blower keeps a large ball suspended in space in another exhibit. There is an intriguing moving discharge in an unusually large plasma ball. A toy electric train can be put in motion by hand turning a small electric generator. Precession is nicely demonstrated by a motor driven fly wheel which can have its axis of rotation tilted, causing it to swing about a vertical axis. There are other interactive exhibits of electricity and magnetism of a more well known sort, well set out for the public. Others in the field of fluid flow and mechanics are also well presented.

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SEVEN SCIENCE CENTRES

The Wollongong Science Centre

This small but active centre is associated with the University of Wollongong. It demonstrates what can be achieved with limited resources. A general view of part of the main hall is shown in figure 1.

One simple but effective demonstration is of the variation of the retarding force produced by the wind resistance of objects of different shapes is shown in figure 2. Air flow from the left, triggered by the visitor, flows past two objects. One is shaped like a pyramid and is supported on a horizontal axis with a counter weight which keeps its sharp end pointing directly towards the source of the air flow when there is no air flow. A cube shaped object is mounted in a similar way beside the pyramid. Its flat faces are vertical when there is no air flow. When the air flow is triggered both objects rotate backwards about their supporting horizontal axes. The rotation of the pyramid shape is much less than the cube, demonstrating its lower wind resistance.

A Foucault pendulum in the main hall may be seen slightly to the left of centre in Figure 1. Of particular interest here is a ring of dominoes set up on the base of the pendulum. These are progressively knocked down by the swinging pendulum as the base rotates relative to the plane of vibration of the pendulum showing the earth’s rotation.

One of a pair of reflecting sound dishes may be seen at the top right of figure 1 and an ever-popular harmonograph.

Figure 1 Part of the main hall of the Wollongong Science Centre.

Figure 2 Wind tunnel with two objects of markedly different wind resistance.

The National Science and Technology Centre in Canberra

The National Science and Technology Centre in Canberra is housed in a splendid new building in the parliamentary triangle beside Lake Burley Griffin and has a very wide range of interactive science exhibits. With its team of blue coated “Explainers” to help the public understand and enjoy the host...
of exhibits it has a reputation for fascination reaching far beyond Canberra and Australia.

One popular exhibit is the Earthquake Machine which incorporates heavy engineering with its hydraulic drive and not easily duplicated. There are also many very simple exhibits which are educational and easily duplicated of which we have space here to mention only a few.

A very successful series are the science puzzles, figure 3. One which is easily duplicated is the "Gone Vest" exhibit. This consists of a jacket and vest of different colours which can be donned by the visitor, the vest beneath the jacket. The problem is to remove the vest without removing the jacket. It can be done as, topologically speaking, the vest is not completely inside the jacket unlike, for example, the yolk of an egg which is completely inside the shell of the egg. Through a series of discrete steps illustrated on a panel on the wall beside the exhibit the object of the exhibit can be achieved by the visitor. These steps are the same as removing a bra from beneath an open necked dress without removing the dress. The visitor thus learns some topology, how for example a tea cup with a hollow handle is topologically speaking the same as a donut.

Manacles which bind visitors together and from which they have to escape are also of topological interest and always popular, figure 4.

Corner reflectors consisting of three mirrors at right angles to one another are a simple but instructive exhibit. Three of these are mounted in the corners of a rectangular frame suspended above the visitor with an ordinary single plane.

Figure 4 The Manacles in use at the NSTC in Canberra.
mirror in the fourth corner. As the visitor moves about beneath the frame, the essential property of corner reflectors can be illustrated since the corner reflectors always reflect light exactly back to its source. No matter where the visitor stands beneath the frame he or she will see themselves in each of the corner reflectors but this is not so for the single plane mirror.

The application of such reflectors to measuring the distance between the earth and the moon is explained. Shiny metal corner reflectors placed on the moon by the astronauts reflect laser light pulses from a laboratory on earth. The light pulses return from the moon exactly back to the same laboratory. The time for the return journey is accurately measured and knowing the speed of light, yields an accurate value for the moon-earth distance. Traffic reflectors are made up of a large number of tiny corner reflectors which cause the reflected car headlight beams to always return to the driver as he moves along, thus clearly defining the edge of the road at night.

The planetarium seats fifty two people, arranged in a circular theatre with a domed roof. Located at the centre is a Zeiss ZKP-1 projector. This is relatively small as projectors of this sort go, being less than one metre in length along its main axis, but it is nevertheless a precision optical instrument which produces sharp star and other images on the domed ceiling. Around the bottom edge of the circular dome of the theatre is a silhouette outline of the skyline of Launceston. Four separate ordinary projectors located around and in the circular wall of the theatre show images of, for example, the early astronomers. These images are associated with the particular story being told at the time. While the writer was there in November 1992 the story of the evolution of the Sun was unfolded. A prerecorded account was used with linked voice and images, followed by an account of the night sky above Launceston given live by the projectionist.

While such a very expensive facility cannot be easily duplicated, it is possible to construct a simple one which shows the basic aspects of a planetarium at relatively small expense, based on two concentric spheres. The inner star sphere has a bright light inside it and holes in its surface corresponding to some of the nearer stars and planets which are visible from the earth, with translucent paper behind each opening. The outer sphere has a series of small lenses which focus the light from these holes upon the inner surface of a hemisphere of much larger radius which is also concentric with the two inner spheres. The outer surface of this hemisphere represents the night sky. The two inner spheres can rotate on a common axis which is parallel to the polar axis of the earth. At the latitude of Canberra (36°) the common axis would be angled away from the vertical by 54°. The whole exhibit would be set up in a light tight enclosure.

The Scienceworks Museum of Victoria in Melbourne

This science centre is in an impressive new building in the suburb of Spotswood adjacent to the Westgate Bridge. It has a substantial number of static exhibits like historic cars and trams as well as a range of interactive science exhibits.

People are often interested in quite small scale scientific demonstrations. There is an excellent such demonstration of the variation of electrical conductivity of materials. Mounted behind glass are separate coils of plastic, nickel, wood and copper. By pressing an external button the visitor can apply an electrical potential difference between the ends of these, one by one, and look at a meter to see the current that flows. The essential differences between insulators and conductors is made evident.

The power savings of low energy fluorescent lamps compared with ordinary incandescent lamps is clearly demonstrated in a similar manner. This may convince people to reduce their electricity bills and hence indirectly reduce global warming.

The Investigator Science Centre in Adelaide

This science centre is housed in a very large barn-like building in Adelaide. It contains a range of relatively well known interactive science exhibits, all well presented. There are, in addition, some that are unique, educational and simple, and two of these are described.

The first is a small running track along which the visitor can test his or her time for a fixed distance. Entry and exit times are electronically controlled and the time for the run displayed next to that for a famous local athlete, figure 5. To make the exhibit more dramatic a series of vertical panels mounted side-by-side along the track light up progressively as the runner moves along the track.

The second is a rectangular oblong container mounted vertically and painted dark inside. One side panel is made of glass so the interior can be viewed. A dropper at the top lets a continuous series of water drops fall through the container. A strobed light illuminates these drops. The visitor can vary the frequency of the strobe, freezing the water drops in motion.

The writer was able to witness one of the science shows “Spinning” put on at regular intervals (see figure 6). This excellent show contained demonstrations of the stability of rotating systems, centripetal force and precession. The audience was asked to help at appropriate points in the show.
The Hong Kong Science Museum

One of the most interesting exhibits in the Hong Kong Science Museum is the communication area. A narrow vertical red light source about 1.5 m in height and 2 cm in width is mounted so as to be seen from a distance. The light sparkles and scintillates like laser light. When viewed from a distance of about 10 m with the observer’s head still, it is just a narrow light source. However, when the viewer’s head is moved from side-to-side the vertical light source is transformed into the outline of a telephone. The intensity of the red light source is in fact continuously varied along its length with the image information of a telephone. Or, putting it another way, the thin vertical light source is a side-to-side and vertical scan of the outline of a telephone. When this is spread out on the viewer’s retina by a corresponding side-to-side head movement, a two-dimensional visual picture of a telephone results. The exhibit demonstrates the idea behind two dimensional scanning, and could be easily duplicated mechanically; cf. Baird TV.

The well known standing wave patterns which operate with sound waves in closed end tubes is well demonstrated by small white EPS balls distributed along the length of a hollow glass tube about 20 cm in internal diameter. When excited by a sound source at one end these small balls pile up at the nodes and leave the anti-nodes as troughs. It is quite dramatic to see the distribution of these balls change as the frequency of the exciting wave changes, going from one resonance to another.

The variation in bending strength of beams with the same cross-sectional areas but of different shapes, e.g. solid cylinder

Figure 5 Timed running track at the Investigator Science Centre in Adelaide.

Figure 6 The “Spinning Show” in progress in Adelaide.
Figure 7 *Bending strength of beams with differing cross-sectional shapes but same total cross-sectional area being tested by the public in Hong Kong.*

vs. hollow cylinder, is well demonstrated in the exhibit shown in *figure 7*. Here the visitor pulls down on the horizontal bars and notes the deflection of the red painted beams registered on the micrometer dial gauges associated with each beam.

The mechanical strength of toughened glass is tested by standing on it in another simple but effective exhibit. The ghost-like behaviour of the real image of a metal spring hidden behind a panel and projected to the front by means of hemispherical mirrors is shown in *figure 8*. The public can pass their hands through the solid looking image much to their surprise, cf. "Pepper's Ghost".

**Acknowledgements**

The author would like to thank Petronella Sellars of Devonport, Tasmania, and Ann Hoban of Port Augusta, South Australia, without whose help and hospitality visits to the science centres in these two states would not have been so easily possible. Also to engineering student at the University of New South Wales, Caety Tse, who accompanied him to the Wollongong Science Centre and helped with photography. Finally to Dr. Peggy Spratt and Associate Professor Ian Bourne who read and made useful comments on the manuscript.

Figure 8 *Real image of a metal spring hidden behind the panel and projected to the front by mirrors.*
Letters

Accelerated Frames

Dear Editor,

I read the President's column with interest, recognising all the things said undoubtedly to be true.

A few years ago I left school teaching, and am now working as a research scientist, finding in some educational liaison work with "education" as I can, one of the reasons why I was prepared to accept a precarious existence on short contracts in place of a secure job being that job satisfaction had gone from teaching, for many reasons.

One of the more worrying phenomena in science education in the past decade or two has been the drive towards what is sometimes described as "science for all", the apparently laudable programme of extending science lessons and teaching to all children. What is not generally realised is that as a result, while the number of class-hours spent on science has greatly increased overall, this increase has come from extending science lessons to include students who did not previously have science in the curriculum. The amount of science taught to the children who previously studied science seems to have become rather less as the years have gone by, and I am assured by teachers who have lived in Australia longer than I that this has been due to both an overall reduction in the number of hours spent on these children in science lessons, as "physics" and "biology" have ceased to be separate subjects and become "science", and also to a general impoverishment of the curriculum caused both by the need to produce a curriculum suitable, for all, and by the increase in the number of teachers teaching science.

So, agreeing as I do with the tenor of the column, why have I written? After all, I would agree that there can be any number of opinions until the facts are known, after which there is no room for opinion.

I am concerned with the rather facile comment in the third paragraph about Newton's laws of motion and the driving of cars. I have often thought that there ought to be a Newton zero, (rather like the zeroth law of thermodynamics), which would carry the caveat that the laws one to three apply simply only to the situation in which the observer is in an inertial frame of reference.

Now cars are only rarely even an approximation to an inertial frame of reference, and accordingly the descriptions of motion and force of Coriolis or of D'Alembert would be easier to interpret.

I am reasonably confident that even an FRS physicist would, when describing the motion of his car when he had cornered too fast on a dirt road, talk in terms of the "back wheels sliding out", and am confident that many of the difficulties experienced by students with drawing reasonable force diagrams when solving elementary problems using Newton's laws, especially in circular motion, are due to carrying mental furniture, appropriate for an observer making sense of the world as seen from an accelerated frame of reference, into the Newtonian situation in which the observer is implicitly in an inertial frame of reference.


If only your president had not used that particular example.

Kit Bunker

Science Statement and Profile

Dear Editor,

I have just received my copy of the October issue of the Australian and New Zealand Physicist.

I am deeply disturbed by the article by H.H. Bolotin. I am very surprised that such an item would be printed in this journal. In appearance it looks like one of the wilder tirades of a fundamentalist preacher - one remembers the publications of Herbert W. Armstrong with their overuse of emphasis, "inverted commas" and italics. I looked carefully at the shaded box heading the article to read a summary of what he had to say, but found only the first two paragraphs of the article, with no particular reason for their special emphasis in this way.

The article is full of emotive language ("desperation", "self-serving", "catchcry", "zealots", etc.). It makes sweeping statements. It quotes from unattributed sources. It has no bibliography for the help of any reader who might actually persevere to the end. And supposing that it is even possible to decipher just what he is trying to say, he insults anyone who holds a different view. As a policy officer in the Queensland Education Department, I presume that I fall into his category of "professionals" who can't and don't teach. I hope that this statement is covered by the AIP's disclaimer on Page 234. I would have also thought that this debate would not be helped by some members denigrating each other the professional capabilities of other members.

I am not sure quite what Professor Bolotin's problem is. If it is the Victorian Certificate of Education, then why attack all other systems? If it is the Science Statement and Profile, then why attack all eight curriculum areas? If it is all the statements and profiles, then why only mention the Science documents? If he is concerned about post-compulsory education, then why attack documents which are not aimed at it? If he is so concerned about "objective investigation and observation", "fact", "objective reasoning" and "quantitative interrogation", then why publish such an unsubstantiated diatribe?

Professor Bolotin suggests that State Education Departments should raise the standards of their school curricula to at least the level enjoyed a decade or so ago. This is an interesting statement in view of the article on Physics Enrolments in Australian Universities 1983-1993 which appeared later in the same issue. This survey notes an increase of almost 32% in the number of third year physics students since 1990. Presumably these increasing numbers of students came through the school systems as, according to Professor Bolotin, their standards were falling. What does this say about the standards of the universities, if these students were able to persist to third year studies? Dare we suggest that, in fact, school standards have risen? It is difficult to decide either way, but at least the proposed profiles would give us a set of standards to use in reporting the achievement levels of school students. Is there a similar set of standards against which to measure tertiary achievement levels? If not, is it...
Measurement and Quality Assessment

31st MARCH 1994 - RMIT MELBOURNE

This is a one day conference designed to bring together people concerned with measurement methods and techniques to improve the quality of their products and processes. It will focus on research and development in industrial laboratories within the Melbourne area with a view to broadening knowledge of what is happening at the local level. It will be of interest to a broad range of scientists, engineers, technologists and others concerned with quality assurance.

The morning session will be devoted to general topics covering a variety of important advances applicable to industrial measurement areas. The key speakers and the title of their talks are:

Dr Peter Harvey (Kodak)
Assessment of Quality in Products and Processes

Dr Barry Inglis (CSIRO)
Developments in Metrology for the Future of Industry

Mr John Railton (Applied Measurement)
Trends in Sensor Systems

Dr B. Forgan (Bureau of Meteorology)
Does a Graduate With Tertiary Education Move Easily Within the Quality Control Framework?

Mr Norm Parris (EPA)
Targeting Waste Minimisation

Mr Ian MacIntyre (CSIRO)
Vision Measurement Systems

In the afternoon, the Conference will be organised into a number of parallel sessions, each dealing with a specialised area of interest.

The normal registration fee is $85
(Student registration fee is $25)

Further information from:
Mr Ken McGregor (Tel 03 660 3396,
email kenm@bunyip.ph.rmit.oz.au)
or Professor John Millar (Tel 03 660 2602, fax 03 660 3837).

planned to develop such a set, and to put them out for widespread consultation?

Professor Bolotin’s article does echo, albeit in excessively strident terms, misgivings expressed by the AIP in its press release of 30 June (printed in the July issue). This mentioned a petition which was circulated to all university physics departments and containing 480 signatures, “nearly a quarter of the broader based membership of the AIP”. One is left wondering why a decision was made to restrict the possibility of a response to such a narrow group, and why the broader based membership, including teachers and others like myself working in Education Departments, were given no opportunity to comment on the AIP’s actions. One also wonders how many of those who signed the petition actually read or even saw the latest drafts of the Science Statement or Profile.

Despite these misgivings, it is good to see the AIP and its university based members so interested in school science education. I would be even more impressed if this interest were to be translated into sufficient articles for “Fix on Physics” to appear in every issue.

John Martin
Mathematics, Science and Technology Unit
Queensland Department of Education

Correction

Dear Editor,

The article in the October issue by de Lauter, Jennings and Putt entitled “Physics Enrolments in Australian and New Zealand Universities 1983-1993” contains, as in past articles, some very interesting and useful information. It also contains a misleading reference, which should be corrected.

In the Conclusion and in the References, the Australian Research Council is referred to as the author of the report “Physics; A Vision for the Future”. This is not correct. As my Foreword to the strategy indicates, “the ARC encourages peak bodies to commission research strategies within their disciplines” and “provide(s) a significant amount of the necessary funding” (through the Department of Employment, Education and Training’s Evaluation Program).

Authorship of the strategies rests with the appropriate peak body - in the case of the physics strategy, the National Committee for Physics of the Australian Academy of Science.

Max Brennan
Chair, Australian Research Council

ARC SCHOLARSHIP IN HIGH ENERGY ASTROPHYSICS

(equivalent to APA), to join International Project Cangaroo in gamma ray astronomy.

Applications by January 31, 1994 to:
Dr J.R. Patterson, Department of Physics and Maths Physics, University of Adelaide 5005. Tel (08) 303 5996 or AH (08) 396 1004, email jpatterson@physics.adelaide.edu.au

Physicists please help in the promotion of Physics as a subject in Years 11 & 12 by supplying us with illustrated articles for publication in our Education Supplement. Fix-on-Physics. Please send articles together with originals of illustrations and/or black & white photographic prints to the Editor (see address on Contents page).
WHY THE NEED FOR A WIP GROUP?

PINA DALL'ARMI & ANNA RALSTON

When I (Pina) was given the opportunity to co-write this article I read some of the letters that have been received expressing the need for and in support of a Women In Physics (W.I.P.) group. The quotations speak for themselves (with thanks to the writers).

"AUSTRALIA NEEDS THE MOST TALENTED AND SKILFUL PEOPLE TO UNDERTAKE RESEARCH FOR OUR CONTINUED DEVELOPMENT. AT PRESENT, MANY ABLE GIRLS WHO COULD CONTRIBUTE SIGNIFICANTLY IN SCIENCE ARE NOT AIMING TO FILL THESE POSITIONS."

"I AM IN SUPPORT OF A WOMEN IN PHYSICS GROUP AS OUR NUMBERS ARE SMALL AND THE CONTACT BETWEEN WOMEN IN SIMILAR POSITIONS IS WELCOME."

"(BEING INVOLVED WITH PHYSICS DEPTS) HAS GIVEN ME SOME INSIGHT INTO THE SPECIAL, OFTEN DIFFICULT POSITION OF WOMEN WHO WORK IN PHYSICS. I AM DELIGHTED THEREFORE, TO LEARN OF THE WOMEN IN PHYSICS GROUP."

"IN 1991 APPLIED PHYSICS HAD 9% FEMALE STUDENTS. I WOULD BE MOST INTERESTED IN YOUR VIEWS AS TO HOW THE NUMBER OF FEMALE STUDENTS COULD BE INCREASED."

"(OUR) HIGH SCHOOL IS A FOCUS PHYSICS SCHOOL WITH A SPECIAL INTEREST IN 'GIRLS IN PHYSICS'. WE HAD OVER 50% GIRLS IN YEAR 11 IN 1992."

"THE EXISTENCE OF THE WOMEN IN PHYSICS COMMITTEE (INSTITUTE OF PHYSICS, UK) PROVIDES A FOCUS FOR THE GATHERING AND DISTRIBUTION OF INFORMATION WHICH IS OF INTEREST TO WOMEN PHYSICISTS."

"I AM INTERESTED IN LEARNING MORE ABOUT YOUR GROUP, HELPING IN ANYWAY I CAN IN THE ESTABLISHMENT OF A NATIONAL GROUP, AND BEING INVOLVED WITH THE NATIONAL GROUP ONCE IT IS ESTABLISHED."

These quotations highlight the concern among many members of the Physics Community regarding the gender imbalance in Physics and as a consequence they should concern the rest of us as it ultimately means that Physics is losing a large number of talented people. It is sobering to realize that out of all students graduating from Australian and

Pina Dall'Armi and Anna Ralston are both members of the South Australian Branch of the Women in Physics Group.
WHY THE NEED FOR A WIP GROUP?

New Zealand universities with a BSc with a physics major, in 1991 only 17% Australia-wide and 9% across New Zealand were women. Furthermore, of all students graduating with a Ph.D. in Physics from Australian and New Zealand Universities in the same year, only 6% and 11% respectively, were women. The gap widens again, when female members of academic staff in universities are considered: they only make up 6% of academic staff in both countries. The seeds of this gender imbalance are sown in secondary schools. Of all Australian high-school students enrolled in year 12 tertiary accredited Physics course in 1992, only 29% were female.

I believe it is imperative that appropriate measures be taken to increase the number of females studying Physics at secondary level to reach an equitable figure and to ensure that it is maintained at the tertiary level. Increasing the total number of students (female and male) studying Physics at Year 12 is essential if Australia is to produce the technologically literate society that will be demanded in the future. Such a society will also be much more aware of the role that physics plays and will have a greater appreciation of the endeavours of physicists. The future of Physics depends on the co-operation of all its participants and, ultimately, what’s good for women in physics will be good for Physics.

It is important however that before implementing ways to improve the participation rate in Physics it is essential that we consider possible reasons young women are not studying Physics in years 11 and 12 and try to overcome these concerns. My own experiences as a first generation Australian country girl may provide some insight into the possible reasons many young women decide not to study physics or to pursue it as a career. My experiences included being in small science classes and being one of only two girls in a group of eight studying Physics during my last year at school. These problems were exacerbated by loneliness and rigid social and peer group pressures.

For many young women, such concerns can affect their final decision about following a Physics/Applied Physics career. Many times during my science education I had wished there had been a female role model; a teacher or a group of people, that could have shown me and especially my indecisive friends that taking Physics as a subject shouldn’t make you feel abnormal or incongruous with others. If this kind of support was available during my time at school it could have encouraged many of my female friends who had the capability and inclination to study Physics, to actually do so. Also, by educating the general community about Physics and its role within the community, it may have made them understand that Physics is a suitable subject and career for both women and men.

One of the major ways of increasing the number of girls studying Physics at school is through the establishment of a Women In Physics group. Such a group, which organises and publicises events involving students (girls and boys of all ages), teachers, the Physics community and the community in general, can assist in the education, awareness, acceptance and support for studying Physics. Furthermore, by monitoring future Physics Strategy Planning and contributing to final decision making about matters relating to Physics, women, like men can have the opportunity to put forward their concerns and suggestions. Finally, the group by acting as a resource centre and support group for science teachers and girls, may become a major contributing factor in encouraging more girls to study physics and, ultimately, to pursue a career in Physics.

The activities of the South Australian group have so far included organising one-day physics workshops with talks and hands on activities for year 10 girls, running workshops for members on how to give interesting school talks, supplying lists of speakers to schools, and making submissions to the Physics Strategy Plan.

Our final aim is to see a thriving physics community with gender ratios comparable to other professions, and a general public which is better educated about the role of physics in society and in the world. In other words, the Women In Physics Group hopes to work itself out of a job!

In the meantime, if anyone is interested in finding out more about the Women In Physics group, contact Ms Pina Dall’Armi at the School of Physical Sciences, Flinders University of South Australia, G.P.O. Box 2100 Adelaide, 5001, Tel (08) 201 2841, Fax (08) 201 3035 or email phnda@ippinn.cc.flinders.edu.au, for the name of your state representatives.

Acknowledgement

A special thank you must go to Dr Ann Roberts (Melbourne University) for her consultations while writing this article.

Bibliography

1 M.J. Megaw Contributions GASAT VI Int. Conference Australia 1991
2 Australian Department of Employment Education and Training (DEET) ♦

THINGS YOU SHOULD KNOW ABOUT GOING TO PRINT

For full colour printing (the cover of the Physicist) the best print quality is obtained from large format (6cm x 6cm or similar) colour slides. Even 35mm slides will result in a higher quality printed image than a colour photograph (unless the slide has been made by copying a colour print). Colour laser prints and colour photographs should be supplied in their original form and not as copies on colour slides. If you are using a photographer, especially for full colour printing, have transparencies made!

For single colour printing (the Physicist pages) please supply black and white or even colour photographs - NOT negatives or slides. If your artwork is laser printed, please supply the original laser print and not a photographic copy (a bromide). A bromide of your laser print or original drawing will not be of higher resolution than the original and is only worth the expense when multiple copies are required.

"Bromide quality" is an expression that means that we would like as high a resolution as possible for the figures and illustrations that are published in the Physicist.

Australian & New Zealand Physicist Volume 30, Number 12, December 1993 319
TMC Enforce CleanTop Optical Table Patent

Over the last several months, TMC began legal proceedings in the UK against Photon Control (now owned by Melles Griot) for infringing on their patented CleanTop design. After much ado, Melles/Photon has agreed to:

1. Remove their product in question from the market.
2. Destroy their stock of these tables.
3. Pay TMC’s UK legal expenses.
4. Issue a press release to the optics trade Journals stating such.

TMC’s CleanTop continues to be the only table with small steel cups under each tapped hole that do not interfere with the honeycomb.

For TMC’s new catalogue, call Lastek Pty Ltd on tel 08-231-2155 or fax 08-231-2169.

A New Edition of “Physics of the Earth”

The first two editions of Stacey’s “Physic of the Earth” (1969 and 1977) were published in New York by John Wiley. When Wiley let the second edition run out of print, the author claimed the copyright and took early retirement from the University of Queensland to concentrate on writing a new edition. Jointly with his wife, a linguist, whose expertise in readability of texts was applied to the third edition, he established a company to publish it. The result is now being assessed by the international geophysical community.

The first reviews have appeared and more than 30 universities have already adopted or readopted “Physics of the Earth” for graduate and advanced undergraduate courses.

Textbooks with printed as well as written in Australia have become fewer with competition from Asian printers and this book is an attempt to reverse the trend. It is marketed by mail order from Brisbane, allowing the reversal of another trend - it is cheaper to buy in Australia than overseas.

Atlas GIS Software to be Demonstrated

Atlas is the top selling geographic information system brand in the United States. You can see why in Sydney and Melbourne shortly.

A half-day demonstration in Sydney and Melbourne will show the Atlas GIS software in operation in an Australian context. You can see thematic mapping using Australian postcodes and local government boundary files and also the latest GeoData files from AUSLig.

Examples demonstrated by GIS users will include mapping ANZ customers by brand, tracking the geographic incidence of asthma, retail site location and 1991 Census Analysis.

“In a Windows environment, these GIS programs are much easier to use and you can readily import your own database for geographic analysis”, said Dr James Heanne.

Heanne Marketing Software Pty Ltd is sponsoring the half-day seminars in Sydney on 6th December and in Melbourne on 8th December.

For further information please ring Heanne Marketing Software Pty Ltd on tel (03) 866 1766 or fax (03) 866 3318.

Lastek’s New Spectra-Board 2-12

Lastek has developed a dual channel photometer for more convenient measurements of CW or pulsed sources with up to 100 nice time resolutions.

Hardware Features
- Two simultaneous 12 bit A to D input channels with software programmable gain amplifiers and filters
- 100kHz data acquisition rates
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- 2 programmable gated integrators for pulsed signals and time averaging
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Software Features
- MS-DOS drivers
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  (Borland TC++, for MS-DOS)

Applications Software
A complete suite of advanced spectroscopic applications software is available. We designed SPECTRA-BOARD to be a general purpose measuring system for photonic radiometry or spectroscopy. To keep prices low we have kept the speed at 100kHz.

SPECTRA-BOARD was designed by experienced spectroscopists for ease, flexibility and convenience across almost every type of optical measurement you want to make.
- Single or dual channel with ratioing
- Pulse integration, single or dual channel

Bioscope Nanoscope Scanning Probe Microscope

Digital Instruments (Santa Barbara, CA) has released the BioScope, an atomic force microscope designed especially for biologists and life science researchers. It combines an inverted optical microscope with the NanoScope Atomic Force Microscope, giving the researcher the advantages of both techniques.

Samples on microscope slides or in standard petri dishes can be imaged with nanometre resolution. The modified Zeiss Inverted Optical Microscope, on which the BioScope is built, views the sample through the microscope slide or the bottom of the petri dish, and when the area of interest is identified, the atomic force microscope images the sample from above.

The optical microscope, used by generations of life science researchers, and the atomic force microscope, less than a decade old, nicely complement each other’s strengths. With this new tool’s magnification range of 20X to 10,000,000X, and its ability to image in situ in the growth media of the cells or culture, scientists will be able to extend the boundaries of their research.

For information on the Digital product range in Australia and New Zealand, please contact Group Scientific at 13 Lister Avenue, Salisbury Heights SA 5109. Tel/fax 08-258-1940.
PRODUCT NEWS

- Photon counting (32 bit counter)
- Boxcar mode
  (100nscc time resolution)

For further information call
Alex Stanco on tel 08-231-2155.

Pulsed Nitrogen and Dye Lasers

Oriel Corporation has a new line of pulsed UV nitrogen lasers which utilise an innovative hard seal technology developed by their laser research group. This “hard seal” allows significantly longer tube life - up to 18 shots.

Oriel offers a high pressure 600 ps pulse laser, and a higher energy 5 ns pulse version. They also introduced a tunable dye laser module that attaches to the output of either nitrogen laser; it is tunable from 350 to 750 nm. The dye module has two output ports so you can switch between nitrogen and dye output wavelengths. Oriel offers both lasers separately, or as a complete package.

For complete information on Oriel’s new nitrogen lasers and dye module call Lastek on tel 08-231-2155 or fax 08-231-2169.

Poseidon Introduces New Generation of Ultra High Q Microwave Resonators

Poseidon Scientific Instruments (PSI) in Fremantle, Western Australia, have announced the release of a new generation of ultra high Q microwave resonators using the company’s proprietary Sapphire Loaded Cavity (SLC) technology. According to PSI managing director Jesse Sears, the availability of these high performance SLC resonators will allow developers of microwave systems to realise new performance standards for microwave signal generation and processing without superconductors or cryogenics.

The new SLC series of rugged, compact resonators features Q factors of greater than 200,000 at 10 GHz with outstanding stability and noise performance. Utilising a temperature controlled microwave cavity incorporating PSI’s patented resonator design, the SLC achieves a Q, frequency at 2 x 10¹⁵ with residual noise performance of less than -145 dBc at frequency to an external time base for improved long term stability.

The SLC can be configured as a one port (maximum loaded Q), two port (transmission filtering), or three port (reactive resonance pulling) device to suit a user’s particular requirements. Other benefits of the SLC resonator design include the ability to set the centre frequency to six decimal places, high immunity to vibrational and mechanical effects and a superior power handling capability allowing input powers up to 30dBm.

For further information please contact Mr Jesse Sears at PSI on tel 09-430-6659 or fax your inquiry to 09-335-4650.

This new SLC resonator is now available from Poseidon Scientific Instruments in Fremantle WA.
Australia Proves its Scientific Strength

Australia forms part of a small group of countries leading the world in the field of colloid and interface science - the science of small particles, large molecules and surfaces. The University of South Australia's research and development achievements in this field have earned Adelaide the right to host next year's 8th International Conference on Surface and Colloid Science.

The ICSCS is a triennial event which brings together leading researchers, scientists and industry representatives from around the world. Previous conferences have been held in Hungary, Puerto Rico, Sweden, Israel, USA, Japan and France. The 1994 conference, to be held from February 13 to 18, has already attracted more than 540 papers from representatives in 30 countries.

"This conference will provide an outstanding opportunity for an intensive exchange of information relating to recent advances and future developments in surface and colloid science and technology," chairman of the Australian organising committee, Professor John Ralston said.

Plenary speakers at next year's ICSCS include Professor Toyoki Kunitake (Japan), Dr Richard O'Brian (Australia), Professor C.N.R. Rao (India) and Professor Hans Lyklema (The Netherlands).

The program also involves lectures by keynote speakers and contributed papers relating to the following themes:

- Advanced Mineral Processing
- Biosystems
- Disperse Systems and Polymers at Interfaces
- Self Assembly
- Surface Forces
- Surface Structure and Reaction
- Thin Films.

"Australia won the bid to host the conference because it has an excellent research base and a proven track record in the field of surface and colloid science," Professor Ralston said. "The University of South Australia was an obvious candidate because it is a leading force in scientific research and development. It has a strong research capability in chemistry and metallurgy, particularly in the areas of particle and surface technology, and surface engineering."

The University of South Australia's Particle and Surface Technology Research Group is currently undertaking major research programs with Australian and international minerals and chemicals industries. Financial support has been provided by the Australian Mineral Industries Research Association (AMIRA), the Australian Research Council (ARC) and private enterprise.

Professor Ralston said other successful scientific research projects are being undertaken in conjunction with the minerals, chemical, paint and pharmaceutical industries at tertiary institutions around the country, including the universities of Melbourne, Sydney, Hobart, Queensland, New South Wales, Curtin, plus Swinburne and the Australian National Universities. CSIRO and other industry laboratories also provide an excellent focus for research into colloid and interfacial science.

The 1994 ICSCS will coincide with the first stage of construction of a unique, world-class research facility at the University of South Australia. The $20m Ian Wark Research Institute (IWR) - named after one of Australia's most distinguished mineral scientists - will encourage and support the expansion of the university's research and education excellence in close collaboration with mining, mineral and materials processing and associated value-adding industries.

The mission of the Ian Wark Research Institute is to provide a research environment in which there is a continual interaction with industry to solve applied problems using fundamental science.

A trade exhibition will form part of next year's conference and will provide companies with a great opportunity to present products to industry leaders in the field of surface, colloid and material science. It will be located at the Convention Centre in Adelaide where plenary and concurrent sessions will also be held. Equipment and instrumentation on display will cover applications which range from mining and mining materials to pharmaceutical products, paints and advanced materials such as hi-tech ceramics.

An International Conference on Surface and Colloid Science is not likely to be hosted in this country again in the foreseeable future. We urge companies to consider the many advantages this opportunity presents, including product exposure and the opportunity to create sales in Australian and international markets.

For conference or trade exhibition enquiries contact Karen English, Techsearch Inc., GPO Box 2471, Adelaide SA 5001.
Tel 08-267-5466, fax 08-267-4031.
Material for reviews should be sent to:
Dr Colin Keay
Reviews Editor
Physics Department
University of Newcastle
University Drive
Callaghan NSW 2308

Prompt Critical

Two Little Brown Scientific Paperbacks

A couple of new books, good for holiday reading, have just been released. They are from the American publisher Little, Brown and Company, and although both are about physics, they are not at all alike. One is a collection of nearly one hundred choice articles written at intelligent-layman level by big-name scientists and top-flight science writers. The second is a highly personal account of some recent work which, dare I suggest, would have to be in leading contention for next year’s Nobel Prize in Physics.

One might imagine that reading a compendium bearing the kitschy title “The World Treasury of Physics, Astronomy and Mathematics” would be rather insipid to the Average Busy Professional Physicist (ABPP). Quite the contrary. It is a highly recommendable catch-up reading course for those who want to have a better overview of some unfamiliar territory that one lacks the time to explore in any detail.

A few of the essays, such as those by Curie and Planck, date back to the early years of this century. Others, such as Freeman Dyson’s “Butterflies and Superstrings” are as contemporary as one could wish for. The contributions have been selected by an astronomer who switched to become a Professor of Journalism: Timothy Ferris, whose own essay on the Unified Theories of Physics could be read with profit by practically all science-graduates.

Inevitably, in a compilation of this kind, there must be variations in depth. Several chapters are adapted from articles which appeared in Scientific American, which gives some idea of their average level. Their average length is less than ten pages, which is nice when browsing for enlightenment. For a very quick dip, the Treasury includes twenty-one poems and a delightful single paragraph by Dirac about Hilbert.

By way of contrast, the second book, titled “Wrinkles in Time”, is not at all intended for browsing: like a good novel, it is rather hard to lay down. It is George Smoot’s own personal chronicle of the quest to explore the fine detail of the cosmic background radiation and read its message content. As everyone knows, the Cosmic Background Explorer satellite (COBE) succeeded brilliantly in tracing the primordial fluctuations which formed and clustered the galaxies. It is one of the greatest discoveries of recent times.

After four introductory chapters, the story develops from Smoot’s first studies, under the supervision of Luis Alvarez, of the cosmic background barely five years after Penzias and Wilson discovered it. ABPP’s, especially experimentalists, will surely empathise with the observational problems Smoot and his team had to overcome operating their exquisitely sensitive microwave radiometers on balloons, U2 aircraft and, climactically, a satellite. An interlude at the South Pole, to obtain absolute measurements of the contribution from our own galaxy to subtract from the cosmic signal, adds further adventure to an already enthralling tale. Smoot has been ably assisted by his co-author, Kean Davidson, science writer for the San Francisco Chronicle. Davidson has given “Wrinkles in Time” the colour and flow which makes reading a pleasure. It is a pity more of the momentous discoveries of modern physics and astronomy could not be presented by such felicitous collaborations between scientist and professional writer.

The World Treasury of Physics, Astronomy and Mathematics, costing AS27.95, and Wrinkles in Time, at AS29.95, are paperbacks published by Little, Brown and Company and distributed in Australia by Penguin Books.

Colin Keay
Reviews Editor

POSTSCRIPT:
The copy of “Wrinkles in Time” submitted in time for review was a paperback proof copy. The final version is in hardcovers, with excellent colour plates. Surely a bargain!

Reviews

The Ghost in the Atom

P.C.W. Davies and J.R. Brown (eds)
Cambridge University Press, Cambridge 1986
Canto paperback edition 1993
xi + 157pp., AS15.95

From virtual ghosties
And quantum field beastsies
And things that go bump on sight -
Lord God deliver us!

Einstein might well have prayed thus as his attempt to exorcise the ghosts in quantum mechanics by constructing a classical non-linear field theory to replace quantum theory met with frustration and the success of quantum methods mounted.

A prime focus for the strangeness that characterises quantum mechanics has been the Aspect experiment which produced persuasive evidence that quantum correlations of the Einstein-Podolsky-Rosen (EPR) type continue to hold across intervals which cannot be bridged with a light signal. The implications of that experiment and the standard paradoxes form the focus of this book of interviews with eight leading physicists, each of whom defends a different interpretation of quantum theory.

The opening interviews are with Alain Aspect and John Bell, the latter the theoretician whose sharp formulation of EPR made Aspect’s experiment salient. By contrast with the six that follow, their approaches are both noticeably agnostic and pragmatic, expecting that we have more to learn beyond present quantum theory but that we will have to wait for deeper ideas and better experiments to learn it. It was David Bohm who reformulated EPR so as to first make it experimentally accessible and amenable to Bell’s generalisation.

The book closes with interviews with him and with collaborator Basil Hiley, exploring their unorthodox conception of a super quantum field potential version of Bohm’s original ‘hidden variable’ interpretation, a field whose action is non-local and by form alone. In between, there are interviews with leading proponents of the now standard interpretational variants: John Wheeler argues for a real ghost, the conscious observer; Sir Rudolph Peierls defends a Kantian numenal ghost in the form of
Bohr’s Copenhagen interpretation; David Deutsch multiplies ghosts beyond imagination while defending the many-universes interpretation and John Toller seeks to exercise all ghosts by confining quantum theory to the statistical description of measurement outcomes and banning all further discussion.

It makes for a rattling fine set of yarns, with the interviewer pressing each hard on the issues (though sometimes with interviewee attitudes unhelpfully intrusive), the passion and intellectual style of each showing through. You won’t make a lot of sense of it if you don’t already know some of the underlying quantum theory and have some familiarity with the technical details of each of the interpretations discussed. There is a nice, sharp, clear introduction by Davies but it gives no more than a bare introduction and many of the comments made will not be intelligible on its basis alone.

But if you are familiar with the issues and are looking for some great reading over Christmas out on the sandeck, then this little volume provides a thoroughly enjoyable, refreshingly personal insight into the debates still raging within the physics community.

Whichever side you fancy, I leave you with this Christmas reflection: we have seen the ghosts and they are us.

C.A. Hooker
Philosophy Department
University of Newcastle

Conversations on the Dark Secrets of Physics
Edward Teller, Wendy Teller & Wilson Talley

Edward Teller, the father of the hydrogen bomb, is the principal author of this gallant attempt to throw some light onto the dark secrets of physics. And he has succeeded to a certain extent even though this is not a book designed for the public at large.

The deliberate use of equations and mathematics, rightly argued to be necessary even in a semi-serious attempt to understand nature, may restrict the number of readers. But the rewards are great for those courageous few. If the mathematics is new to them, they may walk away with some useful concepts, through which the physics may become more accessible, fulfilling their aim to read the book in the first place. If they already know the mathematics and physics, they still walk away with some unconventional, even unusual, interpretations, and perhaps in awe of what a master can do with both seemingly trivial as well as complicated concepts. Nevertheless, but with some loss, a reader can skim all the daunting mathematics and still enjoy the book.

The historical anecdotes, sometimes involving Teller himself, the thrown-in philosophical remarks and the subtitle, and not so subtle jokes given as footnotes offer some relaxing moments but still convey a certain kind of truth. The observation that we start out with simplicity then complicate matters so much that we can complete the trip back to simplicity is very Zen and reminds me of the martial arts. A novice puts on a white belt and a lot of work to get to a black belt; and after many more years of hard work, the belt loses its colour turning back to white as the person is gradually released from the regimented forms he has followed so diligently.

The book begins unconventionally with a chapter on the theory of relativities and swings back to the beginning of physics to proceed in a chronological order to the present time. All the important concepts and subjects are mentioned if not explained. For example, rather than widening the gap of particles and waves in the duality of matter by stressing their differences, Teller chooses to talk about their similarities instead.

Forefront science and technology such as laser and high temperature superconductivity are also given some space. The questions at the end of each chapter with answers at the end of the book are selective but perhaps a degree more difficult than the level of the text.

This is a general science book with a difference. It should be read by all who are prepared to put in some work to learn the principles of physics, so simple and yet so powerful. It should also be read by those who don’t understand physics. Maybe they can pick up a new point here and there. (Chemists, in particular, should not be deterred from reading the book even though Edward Teller had something ‘against’ chemistry. It should be revealed that whatever he now finds of chemistry (too easy and should be ranked below physics!), he did start out his career with a background in chemical engineering after all.)

T.D. Kieu
School of Physics
University of Melbourne

Carbon: Element of Energy and Life
L. Cram and D. Varvel (eds)
Science Foundation for Physics, University of Sydney, 1993 x11 + 240pp., $20 (paperback)

This book is the admirably swift publication of lectures given at the 27th International Science School for High School Students at Sydney University in June/July 1993.

The seventeen chapters by nine different authors range in length from six to twenty-six pages. Readers of “The Physicist” will recognize Tom Gold (still controversial with his chapter on the origin of natural gas and oil), Dick Collins, Malcolm Longair and David Allen among the authors.

The standard of production is very good (and includes eight colour plates) and the layout attractive. Would that there were more books so well produced, reasonably priced and offering such excellent value.

The various chapters show the different approaches the scientific disciplines bring to the study of carbon— the astrophysicist on the origin of the elements, the geologist on fossil fuels, the chemist/biochemist on life and how chemicals such as antibiotics and anaesthetics help keep us alive, the techniques of carbon dating.

Chapters with a more general emphasis concerning energy, the responses of plants to light and cold, and structural chemistry establish a context for the carbon-specific chapters.

Anyone with an enthusiasm for science will find something of interest in this book.

The impact of Chapter 3 (on carbon in space) is weakened because Figs. 3.2 and 3.3 are the same (despite what their captions say). Impressionable minds should also be spared the punctilious translation of volumes in Gm$^3$ to the doubly offensive trillion cubic feet (Chapters 3 and 7). I had to laugh when I read on p.73 “In geology, the fourth dimension, time, is just as important as the other two dimensions.” The book contains no index, but the bibliographies at the end of most chapters are excellent.

I commend the book to high school librarians and to those who seek prizes or gifts for science-minded students.

P.G. Browne
Physics Department
Macquarie University
 Complexity: the Emerging Science at the Edge of Order and Chaos
M.M. Waldrop
Viking, London 1993
380pp., $24.95 (paperback)

You're not going to believe this, but at the Santa Fe Institute for the Sciences of Complexity, in New Mexico, physicists get together with biologists, economists, even mathematicians. And they talk to one another. The Institute began in the late 1980s in what Waldrop calls "the revolt of the Old Turks", when some of the Los Alamos physicists left over from the Manhattan Project decided to do something interesting while they were still on the planet. They chat about artificial life, self-organizing systems, autocatalytic soups, genetic algorithms, neural nets: the kind of thing one is tempted to dismiss as a fad, but for the fear of an upcoming egg-on-the-face experience. There has already been an "Inaugural Australian National Conference on Complex Systems", so it is time to take up Waldrop's offer of a painless introduction. His book is something like Gleick's Chaos; it's in a racy journalistic style, but he knows his stuff. There is entertaining detail (like why Murray Gell-Mann had to be prevented from heading the Institute), but not too much.

Take it to the beach.

James Franklin
School of Mathematics
University of New South Wales

The Theory of Critical Phenomena;
An Introduction to the Renormalization Group
xii + 464pp., $60.00 (paperback)

A niche exists for a book in the important interface between the theory of critical phenomena and the technology of field theory. I say existed because it has now been most admirably filled by this volume. Readers with typical undergraduate exposure to statistical mechanics and quantum mechanics but little to field theory, will find this introduction to more advanced ideas interesting, readable and with very clear explanations and furthermore with excellent problems at the end of each chapter - all with complete solutions.

It leads gently into the techniques for calculating critical exponents and

Longitudinal Data With Serial Correlation: A State-Space Approach
R.H. Jones
Chapman & Hall, London 1993
xi + 225pp., AUS 74.95 (hardcover)

Longitudinal data analysis concerns observations on subjects followed over time. Medical data is the most typical, as in follow-up studies of patients given various treatments. It applies wherever the history of an individual is important in how it behaves; so more relevant to biology than physics. The author treats well the various models generally fitted to such data: linear, Laird-Ware, ARMA. His main contribution is a state-space approach that permits use of the "tracking" methods of Kalman filters. "First-year graduate level" in statistics is the suggested prerequisite.

There are some helpful pictures, but generally the treatment is not oriented towards visualisation. Given a rich supply of data of unknown nastiness, as may be the typical case in physics, throwing models at the data first is the wrong way to start. Tears before bedtime, no risk. Some exploratory data analysis with suitable visualisation tools will be much more useful; if the shape of the data will take some model, then is the time to go ahead and fit it. The book is also lacking in non-parametric approaches. Again, these may be appropriate to data which is not reasonably expected to fit a model.

Some FORTRAN code at the back (no disk), for those who like that sort of thing.

Anyone suspecting that longitudinal data analysis may be relevant to them should perhaps start with the well-written article on it in the Encyclopedia of Statistical Sciences.

James Franklin
School of Mathematics
University of New South Wales

Multiple-Valued Logic Design:
An Introduction
G. Epstein
Institute of Physics Publishing, Bristol 1993
xi + 370pp., UK£97.50 (hardcover)

This text is aimed at mathematicians, computer scientists and electronic engineers at graduate or senior undergraduate level. All will find issues of interest, however the computer scientist is likely to extract most benefit from the book.

The book has the appearance of being two texts which have been interleaved, on the one hand there are the theoretical chapters dealing with logic algebras, and on the other there are chapters dedicated to showing arithmetic and state machine functions implemented with multiple-valued logic.

My impression is that the text predominantly targeted at presenting the logic, and derivation of algebras for use with multiple-valued logic. The book provides rules, proofs and characteristics for different algebras, and gives many worked examples illustrating logic manipulation under the different algebraic scenarios. In this regard I believe the book has been successful.

The implementation of multiple-valued logic and the circuit design appear to be secondary issues, and within the text are rarely directly related back to the algebras. Also very few circuits are shown where multiple-valued logic is used. 

Australian & New Zealand Physicist Volume 30, Number 12, December 1993
problems are solved without prior transformation into the two-valued logic domain. These issues, complete with some small errors (for example an incorrect I-V characteristic for a diode) detract from what would otherwise be some very well explained sections.

All in all, the book is worthwhile as a course text in this area, or for reference for those outside the field, however prior knowledge of design with binary logic helps considerably in the understanding of the logic and algebra presented.

A.J.C. Spray
Dept of Electrical and Computer Engineering
University of Newcastle

Introduction to Thermodynamics
Keith Sherwin
Chapman & Hall, London 1993
x+309pp., £46.95 (paperback)

This is a textbook for an introductory course on Thermodynamics for Engineering students: and therefore it might be argued that it shouldn't really be reviewed in these pages. University Physics departments do teach thermodynamics of course, but, along with so much else, it tends to get squeezed by the pressures to include more and more topics in our courses. It is interesting therefore to see the subject as engineers perceive it: a useful and necessary area of knowledge that deserves full and detailed study.

This book starts off with a chatty recounting of the history of Thermodynamics; but soon settles into definitions and units which, alas, make less interesting reading. There is an excellent chapter on model building, one which physicists could do well to read. It is refreshing indeed to get an outside view on what is that physicists do when they do physics.

I also found it interesting that there is only one chapter on Fluids: and then only in so far as they are useful as the working material in heat engines. In a physics course, on the other hand, this is the material that is retained: it being the area to which we will later apply statistical mechanics.

In the end however this book will be more useful as a reference than as a textbook for physics teachers. The very detailed later chapters, with their intimate dissection of cycles and heat engines will prove far too specialized. But then again, perhaps it is about time that physics courses rethought their relation with their users. If we are going to teach thermodynamics at all, should we teach it as those who use it want? I wonder how many of our graduates, even the best of them, could cope with the material in this book?

I.D. Johnston
School of Physics
University of Sydney

Radiation Protection Dosimetry
The Natural Radiation Environment
A. Janssens et al (eds)
Nuclear Technology Publishing,
Ashford, Kent
vi+79pp., £150.00 (hardcover)

This book, which is a hefty 800 page set of proceedings from the Fifth International Symposium on the Natural Radiation Environment (Salzburg, 1990) is quite variable in quality and interest. It suffers severely from the constraints imposed by the organisers that contributions should not exceed four printed pages, so that many important pieces of work are presented almost as brief synopses. Equally, there are quite a few rather nondescript four page papers which do not contribute much of significance. Nevertheless, the book has one major merit in that it presents a complete 'snapshot' of virtually all the areas of research which were underway at the time.

Topics covered include improved instrumentation and techniques for making measurements of environmental radiation and radioactivity, a great deal on radon in dwellings and in areas of high ambient levels such as the uranium bearing areas of East Germany, changes in environmental levels due to industrial activities, health effects of natural radiation - including some epidemiological studies of lung cancer in areas of naturally high radon - and mitigation and regulatory strategies to control both radon and other naturally occurring isotopes.

Deservedly, the symposium was dominated by radon, which is now known to contribute about half of the natural background of ionizing radiation, through the inhalation of radon daughters, but there is a sprinkling of papers on other natural sources, including one noteworthy and excellent review of airborne exposures in civil aviation.

This is not a book which I would choose to buy for my private bookshelves, but it should find a place in departmental libraries with a current interest in environmental research. By its nature, it will become dated with the passage of time, but at present it does provide a current view of the field and an excellent source of original references.

K.H. Loken
Australian Radiation Laboratory
Yallambie, Victoria

Solid State Dosimetry
xvii+710pp., £125.00 (hardcover)

The Solid State Dosimetry conferences held every three years attract experts in the field of radiation detection from all over the world. Unfortunately, many researchers from Eastern Europe where some excellent research in the field is conducted could not attend the 10th meeting in Washington (even after the end of the cold war chiefly due to financial constraints).

The proceedings of the conference cover many interesting topics in the field of radiation dosimetry. Papers on Thermoluminescence Dosimetry (TLD) dominate with highlights such as contributions by Y. Horowitz on the new star in the TLD sky (LiF:Mg, Cu, P) and M. Moscovitch on personal dosimetry. Since most important aspects of TLD such as theory, materials, instrumentation and various applications are well covered, the present publication could be used as an up-to-date TLD textbook.

As a bonus, other solid state dosimetry techniques such as electron spin resonance (ESR) dosimetry and bubble dosimetry for neutrons are also well covered in dedicated sections.

Using a well reputed journal (Radiation Protection Dosimetry) for the production of the proceedings ensured speedy publication - important in a rapidly developing field like solid state dosimetry.

The book boosts 145 contributions with an impressive number of figures on more than 700 pages, an authors index and a list of the 189 participants with postal addresses in a hard cover backing.

However, it would be advantageous if such valuable material could be available to more readers in a slightly less prestigious form for a smaller price.

Tomas Kron
Department of Radiation Oncology
Newcastle Mater Misericordiae Hospital
**Book Notices**

**Electrons in Solids**
**The 1990's and Beyond**

Australian Journal of Physics, 46 (5) 1993
CSIRO Publications, Melbourne VIC pp597-728, A$39.95 (paperback)

This is a collection of papers presented at a gathering at Monash University in December 1992 to honour Dr Geoffrey Fletcher on the occasion of his seventieth birthday. The thirteen papers cover a broad spectrum of inquiry as might be expected from the diversity of physicists present. They range from Geoff Opat’s discussion on the effects of gravitational fields on the electrical properties of matter, to Hutton and Troup’s study of impurity centres in Argyle diamonds: electrons, of course, are the common denominator. It is hard to say whether any of the material in this collection will appear elsewhere. The clear group photograph and Guy White’s introduction will make this issue of the AJP attractive to many of those who came in contact with Geoff Fletcher during his long career.

**New Books**

**Physics of the Earth (3rd Edition)**
F. Stacey
Brookfield Press, Brisbane QLD 1992 xii + 513pp., A$68.00 (hardcover)

**Contemporary College Physics (2nd Edition)**
E.R. Jones & R.L. Childers
Addison-Wesley Publishing Company, Reading MA, 1993 xvii + 941pp., No price given (hardcover)

**Bivectors and Waves in Mechanics and Optics**
P. Boulanger & M. Hayes

**Modelling Covariances and Latent Variables using EQS**
G. Dunn et al
Chapman & Hall, London 1993 xvii + 201pp., A$50.95 (paperback)

**Statistical Analysis of Spherical Data**
N.I. Fisher, T. Lewis & R. Embleton
Cambridge University Press, Cambridge 1993 xiv + 329pp., A$59.95 (paperback)

**REMOTE SENSING**

**Earth Remote Sensing**
Robert H. Rapp (ed)
Springer-Verlag, Berlin 
1992 499pp. €129.00 (hardcover)

**Remote Sensing: An Introduction**
D. H. Johnson
Wiley, New York 1992 x + 489pp., A$104.00 (hardcover)

**TO OUR READERS**

Christmas and New Year’s greetings from the Physicist's Editorial Board and from all at Impress Studios.

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**New Zealand Science & Technology Fellowships**

The Foundation for Research, Science & Technology, the handers-out of government money for science research, has initiated a new scheme whereby they fund about 21 schoolteachers per year to work with scientists for periods of one term to one year. The Foundation allows an average of NZ$20,000 per Fellow which allows a school to hire a replacement for the period of absence. The scheme is to allow teachers to gain firsthand experience in science and industry and to enthusiastically convey this information to pupils and colleagues. It also thereby fosters contacts between teachers and industry.

Applications are called twice annually by the Royal Society of New Zealand who administer the scheme for the Foundation. The second round of applications will be called for next February. Employers I have spoken to are keen to support the scheme.

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**Cover Pictures**

We need interesting transparencies or good colour photographs for the Physicist front cover. Send these together with a descriptive caption to:

Production Manager
ANZ Physicist
Impress Studios
14 Ridley Street
Turner ACT 2601 Australia

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Nanostructure and Two-Dimensional Electron Systems
D. Neilson & M. Das (eds)

Numerical Modelling in Combustion
T.J. Chung (ed)
Taylor & Francis, Washington DC 1993 xxiv + 549pp., A$540.00 (hardcover)

Structure and Properties of Composites
R. Cahn, P. Haasen & E. Kramer (eds)
CONFERENCES & MEETINGS

1994

January 17 - 19  International Conference on “Physics & Industrial Development: Bridging the Gap” at the Taj Palace Intercontinental Hotel, New Delhi, India
Contact: Prof S. Chandrasekhar, Centre for Liquid Crystal Research, PB No 1329, Jalahalli, Bangalore - 560 013 India. Tel +91-80-340124 (ext 226), fax +91-80 340492

January 10 - 28  7th Physics Summer School: Statistical Mechanics and Field Theory, Canberra
Contact: V.V. Bachanov, Dept of Theoretical Physics, RSPRESS, ANU, Canberra ACT 0200. Tel 06-249-2943, fax 06-249-4676

January 24 - 28  The 6th International Symposium on Quantum Optics, Rotorua, New Zealand
Contact: D.F. Walls or J.D. Harvey, Department of Physics, University of Auckland, Auckland, New Zealand. Tel 64-9-373-7999/8843, fax 64-9-373-7445

February 6 - 8  Workshop on Rare-earth Magnets and Applications at Charles Sturt University, Wagga Wagga NSW.
Contact: Dr S.J. Collocott, CSIRO Division of Applied Physics, PO Box 218, Lindfield NSW. Tel 02-413-7130, fax 02-413-7383, email stefan@dap.csiro.au

February 9 - 11  18th Condensed Matter Physics Meeting at Charles Sturt University, Wagga Wagga NSW.
Contact: Conference Secretariat, Department of Physics, University College UNSW, Australian Defence Force Academy, Canberra ACT 2600. Tel 06-268-8804, fax 06-268-8786, email waggaw@phadfa.adfa.oz.au

February 21 - 24  NCAR Graphics Tutorial and Conference, University of Technology, Sydney
Contact: Dr K McGriffie, Department of Applied Physics, University of Technology, Sydney, PO Box 123, Broadway NSW 2007. Tel +61-2-330-2219, fax +61-2-330-2204, email kendal@phys.uts.edu.au

Contact: Conference Secretariat, 7th ARSC, PO Box 29, Parkville VIC 3052. Tel 03-387-9955, fax 03-387-3120, email 7arsc@cbr.csiro.au

March 31  Measurement and Quality Assessment, RMIT Melbourne
Contact: K.W. McGregor, Department of Applied Physics, RMIT GPO Box 2476V, Melbourne VIC 3001. Tel 03-660-3396, fax 03-660-3837

Contact: NIR-94, Pastoral and Veterinary Institute, Private Bag 105, Hamilton VIC 3300. Tel 55-73-0915, fax 55-71-1523

July 4 - 8  BRISPHYS 94, 6th Asia Pacific Physics Conference and 11th Australian Institute of Physics Congress in Brisbane QLD.
Contact: Ross Dunlop, School of Physics, Queensland Institute of Technology, GPO Box 2434, Brisbane QLD 4001. Tel 07-864-2327, fax 07-864-1521
email r.dunlop@qut.edu.au

August 24 - 31  The Seventh International Symposium on World Trends in Science and Technology Education to be held at Veldhoven, The Netherlands. The theme is “Science and Technology Education in a Demanding Society”.
Contact: Associate Professor Graham Mulloney, RMIT, Bundoora.
Tel 03-468-2497, fax 03-467-3089
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