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The Australian Physicist

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President’s Column

The award of the first Walter Boas medal was made at a special meeting of the Victorian Branch at the University of Melbourne on 3 October. At an enjoyable dinner Mrs. Boas was presented with one of the medals inscribed in memory of Walter; this memory will now be strengthened through a long succession of awards to Australia's most active and successful physics researchers. The recipient of this inaugural award, Professor James Piper of Macquarie University, gave a stimulating lecture on the history of the development of lasers.

Recently, in his announcement of the very disappointing Science and Technology budget the Minister, Barry Jones, strongly criticised scientists and academics as lobbyists. At the opening of the Sixth National Congress the Queensland Minister for Primary Industries, Mr Mike Ahern, stressed the need for physicists to lobby governments to improve the funding and status of scientific research. Lobbying by the AIP has been increasing for quite some time and I have no doubt that this trend will continue; there are now suggestions that the various scientific professional institutes combine to improve the effectiveness of their lobbying.

I have no doubt that we should do our best to persuade governments, and the community which elects them, of the need for proper scientific planning. I am certain the the AIP will continue to increase its activities in this area. However we should note that the lobbyists are generally attempting to look after their own financial situations (or those of their clients) and aim to use every possible argument which supports their own aims. In our case the motivation is not financial self-interest but a firm desire to see Australia with strong science and technology; also one-sided arguments should not rest comfortably with scientists whose prime aim should be the pursuit of truth — or am I being idealistic?

Editorial

Thank you for your support of the Australian Physicist both as contributors and as readers. It seems that we enjoy our work, and that we like telling about it and reading about it (though there may sometimes be less worthy motives for both activities).

According to the Minister for Science and Technology, Barry Jones, there is a huge untapped audience “out there” upon whom our livelihoods ultimately depend — The Australian electorate. Until these people are enthused about science (and as far as we are concerned, about physics), Mr. Jones will (may?) remain a Junior Minister, and we will receive less support than we think we need. According to the article on Women in Physics from Physics in Canada, it appears that the proportion of women in a profession will also remain low.

There has been some success in lobbying Members of Parliament to interest them in science, but I believe this is a far easier task than taking an appreciation of physics and its potential to the general population. Do we (or can we?) talk to our friends and neighbours about our work? Are we enthusiastic about its possibilities? Can we see beyond the nuts and bolts (or quarks and gluons) of physics to the understanding of everybody phenomena in the physical world, and also applications of physics in the world of ideas, business and leisure?

It seems to me that the direct, matter-of-fact approach of the physicist can be turned to advantage in many organizational occupations (when did logical thought processes prove to be a disadvantage in business?), but the real message we should try to convey is that innovation does not occur successfully without a good deal of background and an understanding of first principles and that even a moderate level of comprehension can have an enormous effect on the efficiency of living. If we are to take part in the age of technology, we must have a reasonable proportion of people who have delved at a deeper level and are building experience of the unknown. The TV repairman can get by with a general understanding of the relevant technology, but to conceive, build and successfully market a new marvel (or even to make significant improvements to existing products, methods or processes), needs an approach which is informed, imaginative and intrepid. It also needs the ability to inform, instruct and inspire.

My big worry is that I am not sure I fit that description!

Jim Graham

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More than twenty five years have elapsed since the first artificial satellite started sending signals back from space. Australia and New Zealand scientists were quick to capitalize on this new tool for the study of the earth's ionosphere. The earliest satellite studies of total electron content and scintillations of the ionosphere were carried out using the orbiting satellites of U.S.S.R. and U.S., the Sputnik and Explorer series. This was followed by studies using the U.S. geostationary satellites such as Syncom, ATS-1, the Intelsat series and more recently the Japanese geostationary satellite ETS-II. Currently the six orbiting satellites of NNSS are providing useful information on the state of the ionosphere. As well as making significant contributions to the experimental observations of signals from beacon satellites, the Australian and New Zealand groups have also contributed to the analysis, techniques and interpretation of the data as well as to the basic theoretical studies.

The following sections provide a brief summary of the contributions made to the ionospheric studies in the 25 years of satellites by Australian and New Zealand groups.

2. The early period — orbiting satellites

The earliest contributors were Hibberd and Thomas (1959) who used British data on the Doppler shifts (Hibberd 1958) of the two frequencies on Sputnik I to determine the electron distribution in the upper regions of the ionosphere. Hibberd (1959) has also investigated the Faraday fading of radio waves from an artificial satellite. He followed this work by studies of the total electron content in mid-latitudes and of the magnetic storm effects on the total electron content using the Doppler effect on Transit 4A signals recorded at Pennsylvania (Hibberd and Ross 1966, 1967).

Nelson (1968a) developed a correction technique for the effects of horizontal gradients. Using this technique Nelson (1968b) then reanalysed the recordings of the Sputnik 3 satellite made at Sydney (33.8°S, 150.6°E) by Munro (1962) during the years of high solar flux 1958-1960 (Figure 1). He compared these results with those of Titheridge (1964b) from New Zealand and with the northern hemisphere results to study the annual and seasonal anomalies in the total electron content.

The advent of the Explorer satellites provided Australian and New Zealand researchers with an opportunity to study the spatial and temporal variations of the ionosphere in the region and also in Antarctica. Singleton and Lynch (1962a, b) at Brisbane (27.5°S, 152.5°E) observing the 20 MHz transmission from Explorer VII found no significant correlation between scintillation index and $f_{E}$. Also they found night time following the region letter, the number one being given to the lowest layer.

The D region height range is from 60-90 km approx.
The E region height range is from 90-170 km approx.
The F region is from about 170 km to the top of the ionosphere. The main ionized region during daytime is the higher F, layer. At night time there is generally only one layer, the F layer.

$E$ or $F$. The ordinary wave top frequency corresponding to the highest frequency at which a mainly continuous sporadic E trace is observed on an ionogram.

Spread $F$ is the spreading of the trace on an ionogram for reflection from the F region. The spreading can be in range (range spreading) or in frequency (frequency spreading).

Sporadic E is sporadic ionization appearing in the E region.

BEB and BEC refer to the 20, 40 and 41 MHz beacons on the Explorer satellites 22 and 27 respectively.
The magnetic K index is a three hourly range local index from 0 to 9 giving a measure of the intensity of geomagnetic disturbance at the place concerned.

Definitions

The scintillation technique measures the perturbations of a radio signal as it transits ionospheric irregularities. During periods of scintillation, the amplitude, phase and angle of arrival of the signal will fluctuate.

The intensity of the scintillations is characterized by the variance in the received power. Two scintillation indices are used to measure quantitatively the received power.

1. $S_{4}$ index commonly used for intensity scintillation and defined as the square root of the variance of the received power divided by the mean value of the received power.

2. $S_{T} / L_{T} = \frac{P_{\text{max}} - P_{\text{min}}}{P_{\text{max}} + P_{\text{min}}}$ where $P_{\text{max}}$ is the power level of the third peak down from the maximum excursion of the scintillation and $P_{\text{min}}$ is the level of the third peak up from the minimum excursion in decibels.

The ionosphere is divided into three regions, indicated by the letters D, E, F. When there is more than one layer within a region, the layers are defined by a number

Fig 1. The average diurnal variation of electron content at Sydney near sunspot minimum. The number of values averaged to give each point is shown. The months during which the observations were made are indicated at the top of the figure. The observations extended from May 1958 to February 1959 and the corresponding results extend from the right to the left of the figure. (After Nelson 1968b). Reprinted with permission © 1968 Pergamon Press Ltd.

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scintillations were associated with Spread F. Theoretical work on scintillations was carried out by Briggs and Parkin (1963) and in particular they proposed the introduction of the S, index commonly used for intensity scintillation.

The investigations of Titheridge in New Zealand covered a wide area in the field of satellite beacon studies of the ionosphere. Titheridge (1963), by recording at Auckland (37°0'S, 175°0'E) the amplitude of the signals from Explorer VII, was able to study large scale irregularities in the ionosphere. The day time irregularities were found not to be field aligned, and appeared to have a wave nature with wavelength of about 100 km. This was followed by a study of the characteristics of large ionospheric disturbances using Discoverers 32 and 36 and Cosmos 5. From the Faraday fading of the 20 MHz signals, the diameters of the irregularities were calculated to range from 10 to 400 km in size (Titheridge 1968a). Periodic disturbances were also studied (Titheridge 1968b).

Theoretical calculations of the refraction of satellite signals (Titheridge 1964a) and an experimental study of the refraction of the transmissions from Explorer VII (Titheridge 1964b) have enabled the determination of the total electron content, the scale height at the F layer peak and the variation of electron density with height above the peak. A comparison was made between the calculated and experimental patterns produced by the distortion of satellite signals on 20 and 40 MHz by isolated ionospheric irregularities (Titheridge 1971a). The Faraday rotation of satellite signals across the transverse region has also been investigated by Titheridge (1971b).

Other investigations of the ionosphere by Titheridge have included the following. A study of the amplitude and polarization scintillation on the transmissions from satellites BEB and BEC over a period of three years showed only a slight tendency to field alignment (Titheridge 1969a). Titheridge and Heron (1971) in a study of the second order effects in the Faraday rotation signals show that the ratio of the Faraday fading rates on 20 and 40 MHz near the centre of the transit can be used reliably during day time to determine the critical frequency of the ionosphere. Titheridge and Smith (1969) have determined the electron content of the ionosphere at latitudes of 5° to 35°S in the Pacific region using the identities of BEB at Rarotonga, yielding information on the transition region from the mid to the low-latitude ionosphere.

Other New Zealand studies have included beyond the horizon propagation of BEB satellite signals to yield information on the electron density near the peak and the shape of the profile (Heron 1972) and accurate angle of arrival studies to determine the scale height (Heron and Titheridge 1972).

Clark, Mawdsley and Ireland (1970), Clark (1971a,b) made a study of scintillation producing irregularities in the New Zealand area using the satellite BEB at mid-latitude and sub-augalor locations. Regular fading of satellite transmissions was found to correlate with sporadic E occurrence in a study by Ireland and Preddey (1967). Kaiser and Preddey (1968) investigated the equatorward boundary of the sub-aualor region of scintillations. Other scintillation studies were carried out by Preddey, Mawdsley and Ireland (1969) who made a study of the morphology near sunspot minimum of mid-latitude scintillation for a chain of mid-latitude to subauroral New Zealand stations and two Australian stations. Preddey (1969) investigated the latitude variation of scintillation from 30°S to 60°S using both ground based and shipboard stations.

Stuart (1972) investigated the characteristics of the abrupt scintillation boundary both poleward and equatorward along the New Zealand meridian using BEB data from three New Zealand stations during the period 1964-1969. Stuart, together with Titheridge, has also determined the distribution of irregularities in the Antarctic ionosphere from sunspot minimum and the ascending phase of the solar cycle by measurement of the occultations in the polarization angle from teh BEB satellite. (Titheridge and Stuart, 1968, 1969, Stuart and Titheridge 1969). Titheridge (1969b) has also studied the horizontal gradients in the polar ionosphere.

Other Australian observers who have utilized the Explorer satellites include Jones who studied the variation at Brisbane (27°S, 152°E) of the scintillation index with the angle the radio ray makes with the magnetic field direction (Jones 1969), scintillations produced by sporadic E irregularities (Jones 1968a), and the variation of horizontal and vertical distribution of ionization in the region 15° to 30°S (Jones 1968b).

Nelson (1968a), using data from three Australian stations at 34°S, 38°S and 43°S obtained from transmissions of BEB during periods of sunspot minimum, determined the total content. He also combined his results with ionosonde data to determine the ion temperature near the peak of the F layer.

Singleton (1969, 1970a) has combined the occurrence of scintillations obtained using observations of the transmissions from the Beacon Explorer satellites from a number of Australasian stations to produce contour diagrams of occurrence and mean index. Similarity between these and the contour diagrams of topside scattering, the dependence of scintillation index on zenith angle and azimuth indicated the existence of field aligned columns. Singleton (1970b, c) has also studied theoretically the effects of irregularity shape, saturation and focusing on satellite scintillations.

3. Geostationary Satellites

The availability of geostationary satellites from 1965 provided an opportunity to continuously monitor the ionosphere. The results obtained from these satellites, Symcom 3, Intelsat 2F2, 2F3, and ATS 1 have been discussed by Titheridge (1973a, b), Essex (1978) and McNamara and Smith (1982). Problems associated with the conversion from Faraday rotation angle to the total electron content have also been discussed by Titheridge (1972a) and Smith (1970, 1971). This data base has facilitated studies of the maintenance of the night time ionosphere (Titheridge 1968e, d, Jones 1974), evening increases (Essex 1977, Titheridge 1968b), the exospheric temperature and composition (Titheridge, 1972b, 1974),

![Fig. 2. The variation in total electron content, peak density and slab thickness of the ionosphere during the magnetic storm of June 1965. The broken lines show the average monthly variation for N and T, while the shaded area in (b) extends one standard deviation above and below the monthly mean. (After Titheridge and Andrews 1967). Reprinted with permission © 1967 Pergamon Press Ltd.

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the effects of geomagnetic activity and magnetic storms (Essex 1979, Jones 1971a, b, 1973, Titheridge and Andrews 1967) (Figure 2) and auroral effects, (Essex and Watkins 1973 and Watkins and Essex 1973). A study of the spectrum of the electron content fluctuations in the ionosphere (Titheridge 1971) provided information on the diurnal and seasonal variation of gravity waves and well as on the 24 hour and 27 day periods. A further study by Morton and Essex (1978) yielded information on the horizontal phase velocity of the gravity waves. Titheridge (1971d) has also made a study of a non-periodic irregularity in the ionosphere.

One of the more significant contributions to the automatic recording of the Faraday rotation of satellite signals was the design of the continuously rotating antenna system of Titheridge (1966) (Figure 3).

![Figure 3](image)

**Figure 3.** Typical records of the polarisation angle of the 137 Mc/s signal from the satellite Syncom 3. One crossing of the chart corresponds to a count of 180 in the polarisation angle and successive crossings are numbered to count of the total change. The rapid fluctuations at a are caused by the movement of small irregularities in the ionosphere, while b shows a wave motion with a period of 29 min, causing variations of ± 0.5 per cent in the total electron content. The record for December 28 shows the thicker trace obtained when the signal weakened (or the receiver is detuned). The rapid excursions at c are caused by the reception of signals from an orbiting satellite. (After Titheridge, 1966). Reprinted with permission © 1966 Pergamon Press Ltd.

Although ATS-6 was not located in the Australasian region, Heron (1981) contributed a paper on the derivation of the ionospheric layer shape from the second order ATS-6 measurements on the 40 MHz carrier phase.

Currently ETS-2 is providing a suitably located geostationary satellite for ionospheric studies in the region.

4. **NNSS System**

The six orbiting NNSS satellites have recently facilitated a spatial and temporal coverage of ionospheric variations not previously available with geostationary or a single orbiting satellite. They have been utilized by Essex and Day (1978) to study the total electron content of ionosphere and by Hajkowicz (1974, 1975, 1976, 1978a, b, 1982a) to study scintillation in the Australian region. In particular the variation of the equatorward edge of the southern scintillation oval with magnetic K index has been carried out (Hajkowicz 1982b). Hajkowicz (1981) in a study of random and periodic scintillations over a wide range of latitudes using the NNSS satellites indicated a close relationship between random and quasiperiodic scintillations. Hajkowicz, Jones and Nowland (1976) provided some of the first evidence for association between small and large scale irregularities in the ionospheric F region by comparing dispersive Doppler and amplitude scintillation measurements from the NNSS satellite signals.

5. **Future Outlook**

Despite the obvious advantages of beacon satellite studies of the ionosphere, e.g. cheapness, continuous operation, portability of equipment, the availability of and support for beacon satellites has decreased in recent years. The many unsolved problems of ionospheric physics, especially ionospheric irregularities which affect our radio communications from VLF to the giga hertz bands, would have been greatly assisted if a suitable range of frequencies on beacon satellites were available. Needless to say, no such beacons are proposed for our own AUSSAT project and the international scene looks even less promising.

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Research in the CSIRO death by a thousand Budget cuts

Lewis T. Chadderton, Chief, Division of Chemical Physics, CSIRO

What follows is the text of a talk, delivered on ABC's "Science Show", Saturday, 29 October, 1984. The opinions expressed are those of the speaker and author. They closely reflect, however, the attitudes, concerns and opinions, of many of the officers of the CSIRO, and of the lay public.

Cuts in Science and Technology

"Sleepers Awake!" was the exhortation. And we thought they had! The charismatic Barry Jones was appointed Minister. A national Science and Technology conference confirmed the need for the harnessing of science for the nation. At last — a government of consensus — a government with the guts to gear up technologically for a real Australian future!

Can it truly be a cause for wonder that Australian scientists should so vehemently vilify Mr. Keating's budget? It is unprecedented, and uncharacteristic, that with one voice, scientists from both CSIRO and the universities should howl with fury at such mean myopia. A leading newspaper columnist has alluded to some well orchestrated and most successful publicity campaign on the part of the CSIRO. It's simply not true! The spontaneous outrage expressed revulsion at the sacrifice of a brightening Australia on the altar of short term political gains.

Australia's science establishment is desperately concerned for the scientific and technological health of the nation; for the land of our children.

The budget figures tell the story. A 15% increase for Defence; 14% for Aboriginal Affairs; 8% for the Australian Atomic Energy Commission (Will we ever have that energy?), and a 1.6% increase overall for science and technology. By the time that hidden costs for repairs and maintenance, for inflation, and for insufficient salary funding are included, the CSIRO research effort is cut — YES, I DID SAY CUT — by 3.2%. In the so-called unprotected areas — and there are quite a number in my own Division — the cuts are up to 4.3%. I emphasize too, that this particular budget is the culmination of a number of years of financial neglect. Previous government slashes, including that delivered by "the razor gang" have left your national research organization deeply wounded. Cumulative effects can also kill!

From Sydney to Perth; from Darwin to Hobart; it is the duty of CSIRO's Divisions to conduct research and development in the national interest. From, say, the

The Author

Dr. Elizabeth Cohen is a senior lecturer at La Trobe University, and is a part of the upper atmosphere and ionosphere group of La Trobe's Division of Theoretical and Space Physics. The group has an array of instruments at Beveridge, 30 km north of the campus, including a new high resolution ionospheric radar purchased this year.

For several years now Dr Elizabeth Cohen has been using both geostationary and orbiting satellites to study the ionosphere, and in particular its irregular behaviour. Irregularities which form in the ionosphere often have a deleterious effect on satellite communications and to be able to explain how and why these irregularities at mid latitudes are formed is a significant problem facing ionospheric physicists.

An associated study being undertaken by Dr Cohen is the monitoring of the high and stable frequency transmissions of VNG, Telecom's time and frequency standards for Australia. When these transmissions are propagated via the ionosphere, the signal undergoes a Doppler shift which can at times become large and also diffuse. These Doppler shifts can be used to study certain properties of the ionosphere.

An earlier version of Dr Cohen's bibliographic article was presented at the International Symposium on Beacon Satellite Studies, New Delhi, in 1983.

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Division of Tropical Crops and Pastures, to the Division of Mineral Engineering; from the Division of Building Research, to the Division of Manufacturing Technology, CSIRO’s research programmes take in the rural sector, secondary industry, and fundamental research.

Effects of cumulative cut-backs can be illustrated for the case of the Division of Chemical Physics at Clayton, Victoria. The number of permanent employees of all kinds has shrunk by 18, to a total of 81, in four years. None may be replaced. The workshop is at one-third strength. There is no electrician! What price safety, then? There is no stereotyped secretary. An automatic telephone answering machine has been installed. Hardly the most supportive environment for a high technological breakthrough!

Despite these adverse factors; despite the obsolete equipment; until now the Division of Chemical Physics has somewhat far exceeded the discharge of its basic community obligations. By adhering, like university research departments — also badly hit — to the basic tenet that the best high technology springs from fundamental research, the Division has been able to export-stimulating, and job-creating innovations on to manufacturing industry. There is now no way in which that momentum, nor that degree of versatility can be maintained.

The example which I have illustrated, for a single Division, is quite representative. Longtime critics of CSIRO see the parsimonious funding as an opportunity to tell us to “trim the fat.” We have been doing that for years, dear friends, whilst the balance of research was shifting from the rural to the manufacturing sector! these budget cuts mean amputation! Vital and viable projects are being severed.

Critics also frequently propose the transfer of all fundamental research out of CSIRO into the universities. That proposal is about as sensible as suggesting the opposite, namely that all university applied research should be removed to the CSIRO. Really! The ignorance of research methods revealed in such proposals is profound indeed. Pure research leads to applied research, which leads to innovation and invention, which leads to high technology, industry, export markets, and job creation. This line of flow is clean, continuous, and incontestable.

It was a recommendation of the Birch Report that CSIRO’s Divisions should move more and more employ young scientists on a short term basis. That recommendation has been implemented, and some of the most brilliant brains have been at work — on a three year basis — for Australian science. Now, the prospect of no possibility of permanent employment is frustrating them beyond all measure. They are joining their university colleagues. The present “brain-drain trickle” will shortly become a “brain-drain torrent”. With a scenario comprising employment insecurity, insufficient funding for both salaries and projects, and the disbanning of internationally-competitive research teams — who will stand, and dare to blame them? We may never see them again! What a national waste!

Technology, say the wags, is the knack of so arranging the world that we don’t have to experience it! High technology, on the other hand, is said to be dominated by those who manage what they do not understand! They say that any sufficiently advanced technology is indistinguishable from magic!

The Minister for Science and Technology knows full well that what REAL high technology offers is nothing less than salvation for this nation. It is vital that the transfer of emphasis from primary to secondary industry be continued in CSIRO, and that proper funding of essential projects be resumed. If this country sacrifices its long-term economic health for measly short-term gains it will — quite simply — find itself rapidly propelled into fourth-rate nationhood. Committed generally to exporting indigenous raw materials, Australia will become a backwater, both isolated from and yet dependent upon our industrious Asian neighbours for reimportation of earlier mineral wealth, fabricated anew into expansive high-tech needs.

Mr. Jones takes every opportunity to compare the technological export tally of Australia with the of other OECD countries. We occupy position 21 — out of 24! Yet even the stark reality of that goes quite unheeded.

What of industry? The 80-20 ratio of government vis a vis industrial R and D in Australia speaks volumes for mismanagement. A finger has been pointed to the silence at this time of the consumers of research. Why aren’t they rallying to the CSIRO cause? Could it be that, unwilling to invest in their own R and D, they now maintain the silence of guilt?

The picture is, of course, somewhat more complex. The spectrum of abilities and entrepreneurial skills is almost as broad and deep in certain parts of industry, as it is in CSIRO. And a case can be made for proper government incentives to inventive industry. In addition the CSIRO, it is conceded, must be tougher and more persuasive in selling its industrial wares. An aggressive CSIRO — to which the word ‘wimpy’ can nowhere else be now applied — has emerged. It is a CSIRO which will more vigorously explain and sell itself to the public! The cutbacks in science funding for CSIRO and the universities have attracted widespread comment. One political scientist, Professor D. Atkikin from the Australian National University writes: “Governments are elected to make wise decisions, not necessarily popular ones, and they have a special responsibility for thinking about the nation’s future. It is time the present Government took its eyes off the polls and focused them on the last decade of the 20th Century”.

Finally, there is a problem, peculiar to CSIRO, which simply has to be addressed. It is that the organization is sometimes seen as monolithic. This must be corrected, and in the current context. An ill-informed observer once referred to the CSIRO as “a grand old battleship, too expensive to convert and too valuable to scuttle”. This naughtiness is not for nothing. If we must have maritime models, then “CSIRO’s 43 Divisions and Independent Units are a flotilla of frigates, corvettes and MTD’s, whose mission is to identify Australia’s submerged technological problems — and to search and destroy”.

For science and technology, Mr. Keating’s budget has launched a devastating wave of Exocet missiles at our own Australian fleet!

The CSIRO — the Commonwealth Scientific and Industrial Research Organization — has rightly deserved the reputation of being the best such national research body in the world. It remains one of this country’s finest assets, and a justifiable source of pride. At another time I would like to speak, positively and with enthusiasm, about the exciting programmes, aims, objectives and achievements of the CSIRO.

For now, however, we have this budget handed down. CSIRO must cancel vital projects, lose its best young staff, face stifled creativity, export rather than develop ideas and innovations, and accept a growing inability to respond to community and government initiatives. It would seem, for science and technology, to be the threshold, of a New Dark Age!

If the sleepers ever wakened — then they slumber once again! So would the last sleepwalker pause, for pity’s sake, and stuff the candle out?

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“Will all matter eventually decay?”
Part II of the article published in June
R. Delbourgo, Physics Department, University of Tasmania.

I shall have to digress into a little history to explain myself more coherently.

Great strides have been made in the last two decades in attempts to unify the four (!) different forces of nature, and we now comprehend a lot better the character of these forces. The four basic forces were distinguished as long ago as 1940. We had the

(a) **STRONG or NUCLEAR force** (which binds nuclei). This was short-range and ascribed to the exchange of mesons.

(b) **ELECTROMAGNETIC** or Q-wave force (which binds atoms). This was long-range and due to the exchange of photons.

(c) **WEAK or BETA**—force (causing radioactivity). This was very short-range and due to the exchange of heavy “weak mesons”, discovered last year.

(d) **GRAVITATIONAL** or G-wave force (binding clumps of matter). This is long-range and ascribed to graviton exchange. Though extremely weak, it profoundly influences the cosmos.

Figure 9: Representation of the four natural forces.

The self-same concepts prevail today but with minor modifications. Nowadays

(1) Protons and neutrons are no longer regarded as elementary constituents of matter. Their role has been taken over by the QUARKS. The evidence is overwhelming that Protons and neutrons are composed of three point-like quarks, sticking together via “GLUON” exchange forces. Quarks come in three complexions or “colours” and, besides, carry other properties called “flavours”. By convention one takes the colours to be the primary ones.

red, green and blue.

The other flavour features include

Upness, Downness, Strangeness, Charm, Beauty, ...

Figure 10: The proton consists of three quarks with different combinations of A and Q, held together by gluons. There are eight colours and flavours which may be exchanged between quarks.

In this way the Proton is construed as overall WHITE and UP, while the neutron is WHITE and DOWN.

\[ p = (u \bar{u})(u \bar{u})(d \bar{d}) \]
\[ n = (u \bar{u})(d \bar{d})(d \bar{d}) \]

The old meson-mediated nuclear force is reinterpreted as the gluon force between quarks.

(2) Electromagnetic and weak forces are one and the same. They hail from a unified “electroweak” scheme in which the Photon \( \gamma \) and the three weak bosons \( W^+ \), \( Z^0 \) and \( W^- \) form a quartet family. It is the exchange of these four bosons at an elementary quark level that is finally the source of all weak phenomena.

![Figure 11: The modern equivalents of figures 9(b) and 9(c).](image-url)
So much for the modern interpretation of the natural forces and the way they operate.

In searching for a synthesis of electroweak and strong forces it becomes crucial to group the quarks (which have a funny A-number of 1/3) with the leptons (which have A = 0) into one big happy family. Unless we make such a union there can be no correlation between their properties and thus no true marriage. Given this union, the mediating forces have as many as 24 different complexions; four of them correspond to the established quartet $\gamma, W^+, Z^0, W^-$, eight of them are associated with the strong gluons, and the remaining 12 complexions belong to new, exotic, coloured force fields which have the ability to transmute quarks into leptons. It is these new, superweak "leptoquark" forces that violate A-number and willy-nilly cause the decay of matter. Because quarks and gluons cannot exist freely (they are glued together in free white matter), we are only able to observe the dissipation of atomic mass number through the decay of white nuclei. Evidently, processes which break A must be exceptionally slow, otherwise matter would have disappeared by now and I should not be here to tell the tale.

Slowness is guaranteed if the leptoquarks are extremely heavy, making them difficult to produce. There are sensitive technical arguments, I assure you, for supposing that the leptoquarks, dubbed X or Y, are at least 15 orders of magnitude heavier than the Proton, this yields a figure of mass of X (or Y) $= 10^{27}$ grams.

Figure 12: Proton decay schemes giving Cerenkov radiation and a positron, or a $\pi^+$ and a positron.

This is a truly enormous mass for an elementary particle since it roughly amounts to a grain of dust! With such an estimate one may go on and reckon the proton lifetime to be in the region of $10^{31}$ years.

You must be wondering how this prediction fares against experiment. Well, without doing any experiments, we KNOW that the proton lifetime exceeds $10^{33}$ years because the universe has been around for some $10^{10}$ years. With a little more personal reflection we know that if the proton lifetime were as short as $10^{10}$ years, we "should feel it in our bones", the point being that humans contain about $10^{27}$ protons, so if these were to decay at the rate of 1 in $10^{10}$ every year, some 30000 protons would disintegrate within us each day — that would make us our own health hazards!

Experiments of course provide more stringent bounds. Nuclear studies, testing for fissioning reactions like

$$^{137}\text{Te} \rightarrow ^{137}\text{Te} \rightarrow ^{131}I \rightarrow ^{131}\text{Xe}$$

inform us that the proton lives longer than $10^{24}$ years. A more sensible approach is to look for the decay products of "stable nuclei". These searches are subject to two important provisos:

(a) One must make quite sure that there is no contamination of the decay process by other natural processes.

(b) One must have enough events to record and accumulate in a run of one year, say, given the anticipated rarity.

In meeting the first constraint (a), we must shield the apparatus from everything else that can interfere, namely cosmic ray background and natural radioactivity. This means going down underground into a mine. In satisfying the second condition (b) we need

Figure 13: Cerenkov radiation is a signal both of possible proton decay and of high energy particles from space. The number of cores of Cerenkov radiation and their orientation help to distinguish proton decay from other events. A neutrino interaction generates only one cascade of electrically charged particles, and so produces only one core of light. (Scientific American, June 1981.)

Figure 14: Thousand-ton detectors in the Silver King Mine, Utah. 800 photomultiplier tubes are distributed through a volume of water on wire frames. The chamber is surrounded by thick concrete and additional particle counters, and the water contains about $10^{20}$ protons and neutrons. (Scientific American.)
a large quantity of material; of necessity the matter must be cheap, so water and iron are the media of choice.

When water is selected as the working medium, the trick is to look for "Cerenkov" radiation, or shock waves of light, as the decay products from the basic reaction

\[ p^+ \rightarrow \pi^0 + e^+ \rightarrow \gamma + \gamma + e^+ \]

travel through it. The water has to be crystal clear and filled with a clean array of photomultiplier tubes for keener vision. See figures 13-16.

On the other hand, if iron is used, then it must be sandwiched with particle counters between alternate layers to track the emissions.

Having burrowed so deeply into the earth and installed our 300 ton apparatus (10^{12} protons) there, the remaining query is whether the background interference has been effectively smothered out. Not quite; some cosmic ray muons and their neutrino partners do penetrate to these depths because of their weak interactions — not many to be sure, only three or so daily. An ingenious way to eliminate this small effect is to pick out events which emanate from the middle of the medium with sought for energies (of about a half a proton mass). By contrast, a muon coming from outside will leave a trail from one side of the apparatus to the reaction point and is easily distinguished.

I expect you are anxious to hear about the experimental results so I will tell you without further ado. But I must prepare the announcements by informing you that the different laboratory groups working in this field have produced inconclusive and slightly conflicting answers. In fact, the various people involved have partially tended to disbelieve one another’s results. There seems to be positive evidence from the

(A) KOLAR GOLD FIELDS (India) at 7000 metres water equivalent depth (mwe). They have 140 tons of iron plates interleaved with proportional counters and find 6 confirmed candidate events with proper energies. Hence they estimate the proton lifetime to be \( 7 \times 10^{10} \) years.

(B) MONT BLANC AUTO TUNNEL (France) at 5000 mwe. The apparatus is iron here as well (150 tons) and sandwiched with streamer chambers. So far they claim to have just 1 confirmed candidate event with the correct energy characteristics. (Three other events ascribed to background muons are rejected.) They say that the proton lives for about \( 10^{10} \) years.

Negative evidence comes from the

(C) SOUDAN FIELD (Minnesota, USA). These people work with only 30 tons of ferroconcrete and operate at 1000 mwe. No clearcut events have been recorded by them to date, so they conclude that the proton lifetime is in excess of \( 10^{14} \) years.

(D) HOMESTAKE GOLD MINE (S. Dakota, USA).

Here we have a 300 ton water cavity at 4400 mwe. filled

\[ \text{The Australian Physicist, Vol. 21, November 1984 — Page 231} \]
with Cerenkov detectors. Again there are no definite proton decay signals so the lifetime is reckoned to be bigger than $2 \times 10^{38}$ years.

I think that a further year of work with all the additional data that will be amassed from heavier detectors should crystallize the whole picture and may well lead to a momentous discovery. My feeling is that we are on the verge of it today. As to what impact such a discovery will have on your daily existence, I fear the answer is N.I.L. I shall not be hastening to change my will just because the proton lifetime is so and so; I imagine it will not matter to you either! Still I believe that the main impact will lie in the confirmation of the principle that A SINGLE UNIFIED FORCE FIELD GOVERNS ALL NATURAL PROCESSES. We will then be much more confident of the scenarios we paint of the early stages of the Big Bang or what will happen to the universe in the distant future. Such speculations will no longer be idle or frivolous.

This essentially brings my talk to an end. Perhaps I leave you with a better appreciation of the significance of A-number conservation and I trust that you will read any news items bearing upon matter decay with special interest and a more acute perception of what is involved. It is appropriate to close with a French saying:

"Tout passe, tout casse, tout lasse",
or, rendered into English.

"All things change, disintegrate and become tedious".

I am convinced that you will agree with the first two parts of the saying and I can only hope that the last part has little relevance for this lecture.

**ARPS in Darwin**

ARPS is the Australian Radiation Protection Society and it is composed of people with a common interest in the theoretical and practical aspects of protection against ionizing and non-ionizing radiations.

Like ourselves, ARPS is full of get up and go and this year it did. It went to Darwin for its 9th Annual Conference. One hundred and twenty people dedicated to radiation protection, travelled to that Territory to talk, tour and tope on the topic.

The presentations ranged from the perspectives and assessments of risks in the world at large to radiodiagnostic protection in Papua New Guinea; from new radiation legislation to new ways of counting the cost or risk reduction; from education and training for radiation safety officers to communicating radiation doses to Aboriginal members of the public.

The theme of the conference was "The Benefits of Radiation — At What Cost?" Conference planners' schemes for themes are not always realised in practice but in Darwin the problems were put into perspective as perhaps never before. The NT Chief Minister, The Hon. Paul Everingham MLA in opening the Conference outlined the political cost and guest speaker Prof. Bernard Cohen, Professor of Physics, University of Pittsburgh, indicated the public's perversity in perceiving the costs. Dr. John Mathews, University of Melbourne, Faculty of Medicine, Epidemiology Unit developed the concept of attributable risk for assessing liability of radiation damage and Mr. Ian Prince of the N.T. Department of Health showed the personal and psychological cost to the individual accidentally exposed to radiation.

In all, 31 scientific papers were presented covering an extensive range of radiation protection activities.

The tours to the Rum Jungle Rehabilitation Project and the Ranger Uranium Mines, Kakadu National Park and Oubri Rock were highlights of the Conference.

On the social side the delegations were very well looked after and the Conference Dinner at the Mindil Beach Casino featured a most thought provoking and witty speech entitled "Radiating Concern" by Dr. James Eedle, Vice-Chancellor-elect of the Northern Territory University.

The Conference venue was at the beautiful new Casuarina Campus of the Darwin Community College. It seemed that all of Darwin, public bodies, private organisations and many individuals conspired with the Committee to make this Conference and our stay in Darwin a delight for the delegates. Our thanks go to all concerned.

Papers from the Conference will be published in "Radiation Protection in Australia". Information on ARPS and availability of the journal may be obtained from the Hon. Secretary, C/ Science Centre, 35 Clarence Street, Sydney, NSW, 2000.

Raymond de Groot
The VLSI Chip

In August 1980 CSIRO announced its intention to establish a research group to design a new generation of silicon chips.

The aim of the VLSI (Very Large Scale Integration) Program, based at CSIRO's laboratories at Frewville in Adelaide, was to develop a design technology that would allow integrated circuits containing the equivalent of 100,000 transistors to be placed on a single silicon chip.

To head the project, CSIRO recruited one of the world's leading computer design specialists, Dr Craig Mudge.

Dr Mudge, born in Port Pirie, SA, and educated in Adelaide, Canberra and the US, had been working for the Digital Equipment Corporation in Boston, specializing in computer architecture; he was also a visiting Associate Professor in computer science at the California Institute of Technology.

When he returned to Australia to head the VLSI project, Dr Mudge brought with him his own technical expertise, many research ideas and a strategy for custom-designing special-purpose silicon chips.

The idea of individuals designing their own silicon chips, and then sharing with other designers the cost of fabrication, was pioneered by two American scientists, Richard Mead and Lyn Conway.

Previously, chip design had been the exclusive province of experts working for large semiconductor companies.

Dr Mudge, as an associate of Mead and Conway, employed and further developed their unique approach to chip design in the new CSIRO laboratory.

Within two years, the small CSIRO group had demonstrated that custom chips with up to 10,000 transistors could be designed in Australia by Australians — university students, scientists and skilled employees from private companies.

Since then, more than 100 individual chip designs have been completed and fabricated, with fabrication costs being shared through the technique of "merging" multiple individual designs on a single silicon wafer — the AUSMPC (Australian Multi-Project Chip) system.

But the custom-designed chip technology was only a preliminary goal, using large scale integration (LSI). The laboratory's ultimate and original goal was to develop in Australia a technology for designing and fabricating very large scale integrated (VLSI) circuits, containing the equivalent of 100,000 transistors — 10 times the density and a technological generation on from the type of chip demonstrated two years ago.

THE FIRST VLSI CHIP

CSIRO's first VLSI chip is essentially a vehicle for demonstrating a design capability. It is a voice recognition chip capable of recognising simple commands spoken by the human voice, and directing other devices to carry out the instructions specified.

Voice recognition is one of the most complex tasks confronting computing science, and the CSIRO chip makes no way pretends to offer a solution — or even an advance — on the present state of the art. It merely demonstrates that from a strictly technical viewpoint, Australia now has the capacity to design a chip powerful enough to handle such a task.

No computer company or research group in the world has yet been able to design and manufacture a single chip that remotely rivals the capabilities of the human ear and brain — one that could accommodate the diversity of human voices, distinguish between similar...

Dr Craig Mudge, founder and Chief Executive of Austek Microsystems, and formerly head of CSIRO's VLSI Program.
decisions are made by humans alone the time and cost involved in designing a chip can become prohibitive. “Bookkeeping” — simply keeping track of the progress being made on a design, is also a major task.

THE “SPRINT” COMPUTER—AIDED DESIGN SYSTEM

Much of CSIRO’s research at the VLSI laboratory has focused on the development of software to streamline the design process and help reduce the complexity of decision-making. Computer-aided design (CAD) was essential to the success of the Australian Multi-Project Chip scheme.

The development of a VLSI design capability has demanded even more sophisticated computer software.

The VLSI team developed and applied a design system called “SPRINT” which enabled the first VLSI chip to be designed very rapidly and cheaply. Rapid design and relatively low cost will be crucial elements in industry’s adoption of VLSI technology.

“SPRINT” embraces a set of CAD design tools as well as a sophisticated design protocol that helps the designer to evaluate options for the placement and connection of the individual components on a VLSI chip.

It employs a hierarchical approach to design in which a design concept is progressively subdivided until it reaches a point where individual design problem areas are reduced to a level which can be comfortably managed by an individual. Designs representing solutions to these problems are stored, and when then component design is complete, are automatically reassembled “from the bottom up” into an integrated chip design.

SPRINT, like the LSI design protocol which preceded it, offers a cumulative approach to design that will further shorten the time required to design new VLSI chips.

A VLSI chip is in fact a number of specialised “sub-chips” which are designed individually by specialists, and then linked to serve a specific purpose. Once one of these “sub-chips” has been developed to what the designer considers an optimum state, its design can be stored on a computer and then simply recalled to serve as a component of another VLSI chip.

Eventually, VLSI designers will have access to an extensive “library” of pre-designed components that can be configured in different ways to produce new chips more quickly, and at increasingly lower costs.

Using SPRINT, a team of six CSIRO scientists, each with skills in particular areas of chip design or software development, took less than a year to develop the voice recognition chip.

As individual members did not necessarily work full-time on the project, the actual design time amounted to less than five man-years for a chip carrying the equivalent of 102,000 transistors.

This development time contrasts with the 150 man-years spent by a United States company on design and development of a 32-bit microprocessor chip containing 68,000 transistors, which recently appeared in a popular line of microcomputers, and which has been used by CSIRO and a Canberra company to develop a micro-node, or specialist communications computer.

100K VERSUS 1000K CHIPS: LOGIC VERSUS MEMORY

An important point to be made is that the type of VLSI chip made by CSIRO is very different to the 1000K, or “million bit” chips that have recently been announced by Japanese and American manufacturers. The million-bit chips are memory chips — they represent a basic component, specialised for memory storage, which has been repeated a million times on a single chip. Although these memory cells pose their own challenges, notably in designing circuits to store and recover the information they contain, the basic challenge is one of miniaturisation, not of complex logic and circuit design.

In the VLSI chip, memory is a secondary consideration — although a VLSI chip may well make use of the huge memory chips now being developed. The VLSI chip is a “thinking” chip, with a number of extremely complex components capable of carrying out specialised functions simultaneously, and connected to allow rapid transmission of data between the different components.

Some components perform “number crunching” operations, some perform logical operations, and others organise orderly internal communication or link the chip with input devices, or communicate with peripheral devices that carry out the chip’s commands.

One major difference between VLSI chips, and their LSI precursors, is that VLSI circuitry can perform simultaneous rather than sequential operations — that is, it can do several things at a time, rather than one after another, meaning very complex applications, not accessible to LSI technology, are now feasible.

WHO WILL DESIGN VLSI CHIPS?

The complexity and cost of VLSI design, even when reduced by CAD systems such as “SPRINT”, will initially place it beyond the reach of most non-specialist private companies.

Chips will probably be designed by specialist companies, working closely with applications engineers from client companies who will be able to define the broad requirements in a chip’s design. Applications engineers from client companies will be able to define the broad requirements in a chip’s design. Applications engineers will themselves probably need specialist training to fulfill the crucial role of linking client with designer.

The foundation for this process has already been laid — quite deliberately — by the custom-designed chip technology, which, by encouraging end-users to design their own custom chips and to take their newly-acquired skills back to university campuses throughout Australia, has “seeded” Australian industry and the research community with a small but competent group of people with the requisite skills in integrated circuit design.
Since the first design seminar organised at CSIRO’s VLSI laboratory in Adelaide only 2½ years ago, hundreds of graduates in electrical engineering have been trained in the Mead-Conway system of integrated circuit design.

More than 450 people have contributed their skills to the design of the 100 custom chips so far fabricated by the Australian Multi-Project Chip Scheme.

WHAT WILL VLSI CHIPS BE USED FOR?
The VLSI design capability represented by the first prototype chip is seen by CSIRO as a feedstock technology - just a petroleum is the basic feedstock for a wide range of chemical industries producing such things as chemicals, paints and plastics.

It is not possible to predict the types of VLSI chips industries will require - however, VLSI technology will open up a range of applications that is beyond that of the established LSI “custom chip” technology.

Such applications might include voice recognition, for “driving” computers or devices for handicapped people who do not have the use of their hands.

VLSI chips also offer new horizons in computer graphics - most chips presently in use are not specifically designed for graphics and have limitations that are presently overcome by linking large arrays of chips. A single specialised graphics chip could “mix” primary colours to expand the range of colours, and with its instantaneous processing ability could offer the speed necessary to generate complex animated graphics for such applications as flight simulators.

VLSI chips may also be used for image processing in devices such as robots, to allow them to “recognise” objects more rapidly than at present. They could also be employed to achieve greater resolution in LANDSAT or similar remote-sensing imagery, and thus, greater information yields.

Such chips could also be used to simplify complex human tasks - for example, flying a helicopter, which requires a high degree of physical and mental co-ordination.

The simultaneous processing capability of VLSI chips could be used to produce a new-generation “bionic ear”, superior to the type already developed by Melbourne University, which employs a LSI custom-designed chip.

The present chip is limited to sequential processing, and is only able to stimulate one nerve at a time, limiting the ability of the device to convey the full “breadth” of complex, everyday sounds. Simultaneous processing would allow several nerves to be stimulated at the same time, making it easier for the wearer to identify sounds and speech.

SIZE OF VLSI CHIPS
The present VLSI chip is about four times larger than an average LSI custom chip, because of the limitations of the materials presently used.

However, when VLSI designs can be produced using Complementary Metal Oxide Semiconductor (CMOS) technology, VLSI chips will become much smaller and capable of being implanted in the human body in applications such as the bionic ear (see above) or perhaps even a bionic eye for the blind, based on a sophisticated image processing chip.

In announcing our new chip last month, Mr Jones warned that Australia would not be alone in seeking to capitalise on VLSI design.

A US company was already establishing a VLSI design centre in Singapore to service South-east Asian countries, and Australia’s new VLSI company, Austek Microsystems, headed by Dr Mudge, could not ignore the estimated $100 million per year international market for VLSI design expertise.

The fact that much of the new company’s work would be done for overseas customers simply emphasized the importance of Australian companies taking up the technology as rapidly as possible.

Austek expects to make a major contribution to the Australian economy stimulating local innovation and supplying Australian companies with design and, later, fabrication facilities. This will result in an increasing supply of innovative goods and services to the Australian and overseas market that will be able to compete technologically with products anywhere in the world” Dr Mudge said.

“We will be establishing design centres in Singapore and Silicon Valley in California and expect to earn 50% of our revenue from overseas markets - all of these activities will be supported from our headquarters at Technology Park Adelaide”.

Austek is leasing accommodation in Innovation House, Adelaide Technology Park’s flagship building which houses a number of new high-tech ventures. Within 12 months, Austek is expected to employ 30 people and to have begun detailed design of its own building complex.

“I want to emphasise that Austek is an Australian-owned company and the majority of its investors are Australians. We are very pleased to have attracted overseas investors including Gordon Bell, father of the mini-computer, and a number of important venture capitalists from the UK and USA. Their involvement is an indication of the potential of the venture and an expression of their confidence in its ultimate success. They also bring strong market links.”

Draft National Technology Strategy

The Draft National Technology Strategy (Australian Physicist, June 1984, pp 115-6) received special attention at the September meeting of the Institute’s Science Policy Committee in Sydney. Mr Randall Wilson, Director of Technology Policy in the Commonwealth Department of Science and Technology addressed the Committee as invited speaker.

Mr Wilson said that to date, about 200 responses had been received by the Department. Federal and State Governments provided 29% of the responses, 23% from academia, 19% from business, 16% from public interest groups, 9% from individuals and 41% from trade unions. Expectations of the strategy are high considering the high level of public interest. Mr Wilson went on to say that most of the comments received have focussed on technology development aspects but there was also considerable interest in the social impact of technological change.

Mr Wilson saw the development of the Strategy taking place very rapidly. It was still uncertain what form the final document could take but possibilities included a “Technology Accord”, an ‘Action Plan’ or a White Paper (ie a policy paper).

The other important matter of policy interest mentioned by Mr Wilson was the recent visit to Australia by a team of OECD examiners. The examiners, Mr Lars Mahnors, Mr Jim Mullin and Professor Emma Rothschild, had the task of examining and reporting on Australia’s science and technology policies. It is hoped that the OECD Report will be completed by 1985.

AIP Science Policy Committee

The Australian Physicist, Vol. 21, November 1984 — Page 235
Never mind the missing links

Some views on the article "Nuclear Power and the Proliferation of Nuclear Weapons" by R.A. Joseph, which appeared in The Australian Physicist Vol 21, May 1984 p82-86.

Views expressed by Donald W. Lang, 22 Tulong Place, Kirrawee, NSW, 2232.

The possibility of nuclear power came onto the public agenda well behind the actual use of nuclear weapons. The first nuclear reactors were constructed to make - with energy as a waste product - the material for weapons. Perhaps it should not be a surprise to read yet another article insisting on the connection between the two. The biggest surprise could well be the sentence "First, nuclear power is still a major force in world energy."

When the Fox report was being compiled in 1975, about as much electric power was coming from nuclear stations as had been produced by all stations in 1939. A lot more stations were in various stages of construction. With omissions (mostly in the USA), and additions, the total in operation is more than double that at the time of the Fox summary, and the total now being built is comparable with the existing total. Yes, it is still a force.

Not so surprising is the following

"Second, the present hull in the debate over the links between nuclear power and nuclear weapons is unlikely to last forever. Countries such as South Africa and Israel have been discreet in recent years over their nuclear weapons capability. It would, of course, only take a threat from a 'new' nuclear nation against one of these countries for it to become a live issue once again."

South Africa and Israel are pretty obvious villains after all. Nevertheless, since the emphasis in the paper was on "...technical aspects of the links between power and the proliferation of nuclear weapons" it is worth pointing out that at July 1st, 1982 neither possessed any operating nuclear power plant with capacity as much as 30MW(e). The Union of South Africa had two reactors under construction with total capacity 1844 MW(e). Israel had two planned with total capacity 1900 MW(e).

"Mr Joseph seems to be convinced that the two nuclear options are still essentially a single option. His main arguments may be expressed by quotations from his article."

"A civilian nuclear industry would provide a base of relevant technology and trained manpower which could be utilised for weapons purposes."

It should be emphasised that the subject is (at most) skill. From the beginning of the nuclear era there has been a string of scientific reminders that there is not and cannot be a "secret of the bomb" - with the possible exception of its initial feasibility. There may be some industrial or military secrets here and there about how to do this or that cheaply or more effectively, but we may as well take the word of those who assure us that all the essentials have already proliferated on paper.

It would be instructive here to write down a full list of jobs available in a nuclear weapons program. I don't have access to one. I don't even have the same information for a nuclear power program. The next step is to compare the two lists and select those jobs which appear on both but not elsewhere in a modern industrial economy. From a lay perspective I find it hard to think of ANY. The nearest that I can come is in the matter of remote handling than is required for the simplest nuclear medicine facility. I hesitate to introduce the subject, but presumably the very large fraction of the population whose lives will be made more comfortable at some stage by nuclear medicine are a good enough argument for its continuation. In any case remote handling of molten metals is nearly as tricky.

Even assuming that skills from the power program are useful to a weapons program, it may well be easier to develop everything in secret than to risk attention by transferring someone out of the visible area once trained. Some of the skills demanded in a public power program by a society which protects individuals may not be required, or may even be regarded as wasteful, for the same set of tasks in a less squeamish and more hurried weapons program.

Again from a lay view, it is not clear how much skill is necessary for a 'weapons contraption' program. When someone unexpected shows this much technical competence, the first reaction has been to wonder if they can even repeat their first gadget. Seven years after the first nuclear test in the USSR, when there had been a lot more of the same, there was still astonishment about sputniks. (Maybe a space program really does require technical competence far beyond that for a nuclear weapons program. The UK has still not put a payload into orbit.) All things considered, it is hard to argue for hiding technology when the skills involved seem to have been self-taught independently several times.

It is next necessary to consider the question "...can plutonium diverted from commercial reactors be readily used to make nuclear bombs?"

Nobody publicises their failure. Those who make weapons seem positively human in this at least. It is conventional wisdom that a plutonium weapon is harder to make than one using enriched uranium. A task of even greater difficulty has been performed. Reactor grade plutonium has been used to produce a nuclear explosion. How difficult it was nobody is telling. The only Public indication is that after it had been done, by people who were well known experts in weapons construction, it was considered worthy of note by the rest of the experts.

The operative word in the quoted question is "readily" and the answer has to be "No". It is worth remembering that it is only by comparison that reactor plutonium ceases to be an attractive weapon. If all plutonium had the uncooperative characteristics of reactor plutonium, the super-powers would still long since have acquired arsenals using it. Most militarists in history would have been very happy to accept a set of bombs with unpredictable yields ranging up to a few kilotons. In our uncertain times a compact terrorist organisation could well decide to use such weapons. A high failure rate would be acceptable provided that there was no visible target for retaliation. It is difficult however to imagine that such an organisation could remain unidentified for long. It is even more difficult to nominate a country that would provide shelter during a prolonged terror campaign. It seems too much to hope that all terrorists everywhere will decide independently that the use of one nuclear weapon will blow cover and remove protection. The threat therefore of even one
terrorist bomb should be sufficient to keep any thinking person from complacency.

Consider now the problems of the 'Nth Country' as it goes about making a credible weapons system with reactor-grade plutonium. The 'scenario' is presumably that, ill-intent, it acquires a stock-pile of used fuel rods. Before anything is detected, the rods have been reprocessed and everything fissile has gone to make weapons. It would appear to involve a massive breakdown of safeguards.

For a nation considering this route it could be extremely dangerous to be caught trying to grab material from outside its borders. What remains is then diversion of spent fuel from its own domestic production. The alternative is going the whole hog and diverting fuel after a shorter irradiation to the condition when it is most suited to be used to produce bombs. It is not clear that any nation willing to face the extra pressure that goes with being a nuclear weapons state would be willing to do so with a second class arsenal — possibly untested. Reactor grade plutonium then has decided disadvantages, even for terrorists, and it appears to be an unlikely part of any other considered weapons program.

The next assertion is rather more wide-ranging. "Safeguards as presently conceived are not an effective way of preventing the proliferation of nuclear weapons."

It is bound to be true that a given set of safeguards cannot be effective forever. There will need to be innovations for special cases such as breeder reactors. There is a further valid point that safeguards don't necessarily work on non-signatories of the NPT. There are enough nations outside, with diverse political systems, to suggest that the treaty itself should be examined for inequalities.

Within the existing system, missing material may or may not indicate something sinister. In chemical plants where material flows continuously quantities are commonly estimated from samples. Any error in a sample can propagate into quite large batches.

It will be apparent that as the fissile material is collected in more concentrated forms there are three important consequences. It is more tempting for theft. It becomes much easier and cheaper to make accurate estimates of how much there is, whether for the owners or for safeguards. Most important, it becomes more valuable to its custodians and therefore more likely to be guarded and accurately accounted.

Within nuclear power installations the trend toward accountable packages is nearly complete. Inspectors can go to where fuel rods are recorded and count fuel rods. Again Mr Joseph finds that the number of inspectors is far from adequate. It is not clear in his article whether he has taken note that some detection systems for some sorts of infringements of the NPT do not require the continuous physical presence of inspectors. The present situation may be more effective than he finds it.

For those whose activities bring them into contact with safeguards, effective safeguards must be visibly effective. It is important to ensure that those who are inclined to acquire nuclear arms will not see a nuclear power program as the soft option. If the nuclear power route is open at all, soft or not, it may well be carried through once started.

Safeguards, like any other deterrent, will have nothing to show for their achievement. It is worth recording that there are over twenty countries with operational nuclear plants. Only six countries are known to have tested nuclear explosives. Mr Joseph expresses suspicions about five more, two of which do not have nuclear power reactors. Part of the basis for suspicion may well be that none of these nations has joined the NPT. It seems dangerous to draw any conclusion.

The next step requires two supporting quotations. "A small simple reactor fuelled by natural uranium, together with a small reprocessing plant to extract plutonium from spent fuel would be less difficult to construct and less costly (by at least a factor of 10) than a commercial power reactor together with even a small commercial type of reprocessing plant. A non-nuclear country would therefore prefer this type of facility to the commercial reactor if it wanted to obtain plutonium for military purposes."

Having quoted this statement, Mr Joseph apparently finds it irrelevant in an immediate particular case.

"When India exploded a nuclear device in the Rajasthan desert in 1974, the gap between civilian and military uses of the atom effectively disappeared."

The Indians presumably know the truth, and possibly do the CIA and one or two other espionage organisations. The public claims, as far as I know, are still diametrically opposed. The Indians set up a reactor capable of making plutonium, a reprocessing plant and an experimental reactor fuelled with plutonium before they had any power reactors. They then acquired power reactors from Canada and the USA and exploded a nuclear device. When last heard, the blame for being the sole source of the weapon grade material was accepted sadly in Canada and similarly in the USA. The credit for completely independent production was then proudly in India. It is of course trendy to take the unsupported word of any third world source over any Western source. It is presumably megatrendy to know when to do the reverse. As a central feature of the article the Indian history needs considerable further work before it can be claimed as a jewel in either crown.

The Israeli raid on the Egyptian construction work is again a murky intelligence area. It is still dismissed in some places as an Israeli domino elecctioneering ploy. Time and memoirs may produce clarification. As Mr Joseph points out "...a study of how technical arguments have been manipulated to achieve political and business interests would be the subject of another paper."

Meanwhile the progress of the conventional war between Iran and Iraq continues to be measurable in months per Hiroshima or Nagasaki per 'final' offensive. There does not seem to be any conclusive contribution to any nuclear debate.

Since the subject is "Nuclear Power and...", it may well be worth comment that Israel became sensitive about something called a research reactor, while the United States appears unconcerned as Cuba — not a signatory of the NPT — constructs a much larger power reactor.

The article also includes some recent ideas from SANA to help avoid proliferation. SANA suggests that the promotional aspect of the IAEA should be incorporated into an "International Energy Agency. The new organisation would be charged with promoting all types of energy development in the Third World and in particular aim to assess the most appropriate energy technologies for each developing country." It sounds regrettably paternalistic. I wish I had seen the word 'conservation' given equal space with 'promotion'.

SANA also suggests "The nuclear weapons states must [make] participation in the treaty more attractive by providing internationally agreed, legally binding security assurances not to use nuclear weapons against the non-nuclear weapons states that sign the NPT."

Such assurances have a hollow ring. One of the major problems identified in the existing NPT is stated to be "No sanctions exist for countries which break the safeguards they have agreed upon." What happened to Belgium in 1914 is only one of the many examples that
if the causes of war are left untreated then any treaty binding participants in their methods of waging it is ineffective. This too "...would be the subject of another paper."

In the main Mr Joseph has reminded the physics community that proliferation and the "Nth Country Nuclear Weapons Problem" still exist. The linkage he sees between nuclear power and nuclear weapons is less than apparent despite his careful presentation of this view.

**Thermoluminescence Dating and Outer Space**

A.J. Mortlock and D.M. Price, Physics and Theoretical Physics Department, Faculty of Science, Australian National University

The technique of thermoluminescence (TL) dating was pioneered and made practical for determining the ages of ceramic objects (e.g. fired pottery) at Oxford University over a decade ago.

It has been in routine use at the Australian National University in Canberra for almost as long and many and varied have been the objects tested, some less than one hundred years old, others several thousand years old. Time zero in these cases is when the object was kiln fired. At this moment all the TL energy is drained out and during the period between then and now it is stored up steadily again in the fabric of the pot due, in the main, to the presence of tiny amounts of natural long-lived decaying radioactive elements present in the clay from which the pot was made. A controlled heating of a tiny sample taken from an incoherent portion of the pot gives a small pulse of light — the so-called thermoluminescence — and the strength of this is stronger the older the pot. After calibration this allows the age of the pot to be calculated, providing the annual energy dose rate is known. The ancient Aboriginal baked fire hearths at Lake Mungo, N.S.W., which behave like fired ceramics, were dated by the same technique to between 30,000 and 40,000 years old by Bell (1978). This demonstrates the diversity of the technique.

Many people have brought their treasured pots and other ceramic objects to the laboratory in Canberra over the years for authentication. The work is presently carried out for a fee of $120 and, if the test is successful, a certificate is issued. More than one such person has been disappointed to find that the treasured object is indeed not so old as was thought, but perhaps a fake made within the past hundred years and passed on from hand to hand in the mistaken belief that it was genuine. This sort of routine activity, as distinct from the archaeological work, is perhaps, not the sort of thing universities should be doing and there would seem to be a case for a private laboratory to take on these tests. This has happened with the older technique of radiocarbon dating both overseas and, it is believed, now in Australia. However, the TL-dating apparatus is expensive and require skilled and experienced operators. The costs of tests carried out under these conditions would be expected to rise substantially if this were to happen.

More recently the TL-dating technique has been extended into the area of geophysics and geological sedimentary layers seemingly can now be dated in some cases, see Mortlock and Price (1980). Time zero is when the sedimentary layer in question last saw sunlight before being covered by subsequent layers. Ultraviolet radiation can drain TL energy away in the same way as heating at least to a first approximation. Work is underway in various parts of Australia, particularly the A.C.T., N.S.W. and S.A. both on land and in sea sediments to test the overall validity of this extension. The application is not without its problems because the surface TL signal is sometimes very appreciably different from zero for unknown reasons.

A Japanese physicist by the name of Mioni and two Italian colleagues of his, Cini Castagnoli and Bonino, have worked in co-operation on cores taken from beneath the Tyrrhenian Sea off the west coast of Italy. They have reported (1982) seeing spikes in the TL signal from sedimentary layers taken from these cores which can be correlated with six historical supernovae (SN) explosions in outer space visible from the Northern Hemisphere. The thought that emerges is that the gamma rays produced from these SN explosions have deposited energy in dust in the upper atmosphere which eventually settles into the sea and then onto the sea bed. Admittedly it is not explained how the light from the Sun does not drain this energy away before this happens, unless the particles are bigger than one would expect.

The fact remains that the spikes in the TL signals correspond remarkably well: the Crab Tau A SN explosion at the year 1055AD is a good example of this correspondence. The independently measured sedimentation rate in the sea bed gives a time for the occurrence of the spike. It is also possible to calculate the total energy given out by the SN burst by calibration of the height of the spike using a 95Co source and this, according to the authors, agrees with commonly accepted theoretical estimates. For example, the Crab Tau A (SN) yields a figure of $4 \times 10^{44}$ joules.

Recent work by the Canberra group at Lake George, N.S.W., not far from Canberra and more detailed than the study referred to earlier reveals a single spike in the TL signal at a depth corresponding to 5,400 years ago. Of course there are no historical SN records to check this against in this part of the world, so further work is proceeding to see if the spike if perhaps to be found in other sedimentary cores from other parts of Australia. As Mioni and his colleagues point out, the gamma rays from solar flares might also produce terrestrial records of the same type. The Lake George spike which was based on six observations was calculated to correspond to a dose of 4 krad over and above background, which can be compared with the figure of 5 krad for the Crab Tau A (SN) of Castagnoli et al. (1982). One can wonder further whether such doses might or might not have produced biological effects on the surface of the Earth.

The ephemeral nature of Lake George and the possibility of a single piece of debris coming into the Lake bed during a storm when the water level was high cannot be excluded, although there is no visible evidence of this in the core. Work on other cores from the same area is proceeding. Whether or not it all turns out to be due to other causes, at least the ideas are exciting.

References:


Walter Boas Medal: Inaugural Award

The first presentation of the Walter Boas Medal of the Australian Institute of Physics was made to Professor James Piper of Macquarie University during an impressive ceremony held at the University of Melbourne on Wednesday, 3 October. Such an historic occasion deserves to be recorded, and in a factual rather than interpretative manner.

The formal part of the evening was introduced by Dr. Robert Leekley, the Chairman of the Victorian Branch, who noted that the AIP had just celebrated its 21st birthday: a coming-of-age appropriately marked by this first medal presentation. Dr. Leekley pointed out that credit for the basic idea of the medal and for much of the ground work leading to its foundation belonged to Professor Tony Klein, whom he then invited to introduce the inaugural recipient.

Professor Klein made the following remarks:

Ladies and Gentlemen:

We are privileged tonight to be present at the start of a tradition, to become an annual event; the inaugural presentation of the most prestigious award of the Australian Institute of Physics — The Walter Boas Medal. I am honoured to be associated with this event, and I would like to welcome members of the Boas family, Mrs. Eva Boas and Mr. John Boas.

Dr. Walter Boas, who died on May 12, 1982, was not only one of Australia's most highly respected scientists, but friend, colleague and mentor to many of us here tonight. Internationally known and recognized for his work on the physics of metals and their behaviour under stress and deformation, Walter was for many years Chief of the CSIRO Division of Tribophysics where he was "father" to a hand-picked group of Australia's most promising young scientists, many of whom rose to great distinction under his guidance. For many years he was also closely associated with this University and with this Department. He was a Fellow of the Australian Academy of Science and of many learned societies, both here and overseas, and was a strong supporter of the Australian Institute of Physics, of which he was a foundation member and Honorary Fellow. He was a man of boundless enthusiasm and irresistible good humour; a loveable and humane man, henceforth to be commemorated annually by the award of The Walter Boas Medal for "original research work making, in the opinion of the examiners, the most important contribution to Physics".

According to their report, the examining panel had a very hard time in this inaugural year, having to choose from a very strong field of candidates; but their verdict is clear. The Walter Boas Medal for 1984 will be awarded to Professor James Piper of Macquarie University for his outstanding work on the mechanisms of visible and ultraviolet gas and vapour lasers.

Professor Piper is known to many of us here — he was our guest earlier in the year when he gave a talk to this A.I.P. Branch. While this reflects great credit on the local Branch Committee — they clearly knew how to pick good people to give talks — it is a bit hard on Professor Piper to have to address the same branch twice in one year. However, he will rise to the occasion I am sure.

Professor Piper comes from New Zealand, where he did both his undergraduate work and his Ph.D. at Otago University in Dunedin. After a stint as a post-doc. at Oxford he came to Macquarie University in Sydney, where he founded Australia's strongest and most distinguished laser group. To quote from the report of the examining panel "A significant part of Professor Piper's work is that he has been able to stimulate a large group of colleagues, post-doctoral fellows and doctoral students. In addition to the intrinsic worth of his research, it is felt that this aspect of his work would have appealed to Walter Boas".

Ladies and Gentlemen, I would now ask Jim Piper to talk to us about "Lasers in Review: Perspectives of Past and Future Developments".

Professor Piper then presented a wide-ranging, personal and entertaining review of the whole history and development of laser research and technology; a survey to which the present correspondent can in no way do justice. In addition, it is a requirement of the medal that the winner prepare a brief summary of his work for a wide general audience. The reproduction here of Professor Piper’s summary is therefore both desirable and appropriate:

In the past decade the laser has thrown aside the mantle of the "solution looking for a problem" and found a host of genuine applications in science, industry, medicine and many areas of commercial enterprise — rather the problem is now that of finding the right laser for a given application.

Development of new lasers with desired properties of, say, wavelength (colour) or power for particular applications requires detailed understanding of the inner workings of lasers. Such understanding is gained from basic studies of electronic, atomic and molecular processes in the lasers, as well as investigation of the technological problems associated with them, of using high voltage discharges, for example, or of handling very reactive and toxic chemicals at high temperatures. Professor Piper's research program at Macquarie University in Sydney embodies a very wide range of techniques of modern physics, all applied to the goal of developing new lasers for a variety of applications of both national and international importance. With the exception of some recent work in development of colour-tunable lasers based on fluorescent dye solutions, the program has concentrated on ultra violet and visible gas lasers.

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Metal ion lasers are low-power continuous lasers which can generate many different colours simultaneously and which as a result have potential application in laser writing and colour display. In the past few years many of the technical problems facing development of practical metal ion lasers have been solved at Macquarie, so that small-scale devices with good operating lifetimes can now be made.

The mercury bromide excimer laser is a high-power pulsed laser giving a blue-green output which is ideally suited for underwater communications and remote sensing. Professor Piper and his colleagues have identified many of the important processes which occur in these lasers and have been able to design a new device which can operate safely at high pressures and temperatures to give short-pulse output in the megawatt power range. Othm excimer lasers, the rare gas halide lasers which generate high-power ultraviolet pulses, have also been studied, with particular emphasis on methods for converting the ultraviolet beam into a blue-green beam for use underwater.

Pulsed metal vapour lasers, such as the copper and gold lasers, give very high powers in the green and yellow (copper) and orange (gold) and have important applications in photochemical processing (say in preparation of very pure substances) and medicine. Following a lengthy program investigating the basic properties of these lasers and the technology involved Professor Piper has been involved in development of practical metal vapour lasers for use in laser cancer phototherapy and other medical procedures. This laser is now undergoing trials at the Cardiothoracic Centre.

A new form of metal vapour lasers, of which the strontium and calcium lasers are most important, is the most recent subject of interest at Macquarie. These lasers can produce high-power blue and violet beams and can be used for similar applications to those of the copper and gold lasers (the blue and violet outputs have many advantages, however). Professor Piper's group are world leaders in this field having obtained the best performance ever with these lasers.

A significant part of Professor Piper's work has been the establishment of a strong group of researchers working in a new and technologically important field of physics in Australia. In doing so he has been able to stimulate a large group of colleagues, postdoctoral fellows and postgraduate students, providing a valuable body of expertise within the country. That this expertise is being utilised in the development of commercial products within Australia as well as in the various spheres of government interest is a matter of pride for Professor Piper and his group.

Dr. Leckey then invited the federal President of the AIP, Professor Geoff Wilson, to make the presentation of the Walter Boas Medal for 1984. Professor Wilson recalled his own first encounter with Walter Boas when, as a young Monash research student, he had given his first conference research paper. Nervous and uncertain of how his talk had been received by the audience, Professor Wilson remembered with pleasure Dr. Boas' friendly hand-shake and congratulations. Professor Wilson then thanked Mrs. Boas for her support of encouragement, Professor Klein for his perception and persistence, the Victorian Branch for its catalytic role, and the selection committee for its work.

Expressing his congratulations and pleasure in presenting the medal to Professor Piper, Professor Wilson noted particularly the technological facet of the research work. Professor Piper, in his response, acknowledged especially the contributions of his co-workers.

The record is appropriately concluded by two notes: first that, during dinner, a duplicate medal was presented to Mrs. Eva Boas in memory of her husband and in appreciation of her support; and second that the official citation reads as follows:

For 1984, the Walter Boas Medal of the Australian Institute of Physics is awarded to

**JAMES AUSTIN PIPER**

Professor of Physics, Macquarie University, for his work on the Physics of the mechanisms of visible and ultraviolet gas and vapour lasers.

In particular, Professor Piper's work on the excitation of high-power pulsed excimer lasers has led to an all-metal high-pressure discharge-excited HgBr laser. In association with this work he has developed high-power ultraviolet rare gas halide lasers which are used for studying photo-dissociation processes in molecules and diagnostic experiments with other lasers.

His most recent work is on the excitation mechanisms of discharge-excited metal-atom recombination lasers using Sr and Ca. Very high mean powers are obtained in the visible and the ultraviolet.

A significant part of Professor Piper's work is that he has been able to stimulate a large group of colleagues, post-doctoral fellows and post-doctoral students. In addition to the intrinsic worth of his research, it is felt that this aspect of his work would have appealed to Walter Boas.

The secondary consequences of Professor Piper's work are seen in a variety of technological and commercial activities and it is correct to acknowledge them here.

**John Jenkin**

**Solar Physics Assoc. of Aust.**

The Solar Physics Association of Australia (SPAA) is an organisation formed in February 1984 with the aim of fostering research in solar physics and encouraging community interest in the discipline. Most of the members (32) are researchers in universities and government laboratories throughout Australia.

Regular meetings are held in Sydney on the last Tuesday of each month. Each meeting consists of a business discussion and an invited talk followed by a buffet dinner.

SPAA is currently investigating Australia's future involvement in solar radio and optical observing programs both in space and from the ground. Recently the Department of Science and Technology approved Australia's membership (via SPAA) of the Large European Solar Telescope (LST) Foundation.

SPAA is organising the Ron Giovanelli Commemorative Colloquium to be held in Sydney from November 26 to 28 this year.

Anyone wishing to obtain further information about membership and/or meetings should contact David Rees, Department of Applied Mathematics, University of Sydney N.S.W. 2006 (Phone (02) 692 3724).
Are there Laws of Physics that are Necessary?

By Peter J. Riggs

The so-called 'laws of physics' are usually interpreted to be inductive generalisations or postulations from particular experiences, which in their spheres of applicability, agree with experimental results. Typical examples include Newton's Laws of Motion and the Heisenberg Uncertainty Principle. Such 'laws' and their corresponding theories are, of course, merely attempts to describe reality, as Popper has commented, "Theories are nets cast to catch what we call the 'world': to rationalise, to explain, and to master it. We endeavour to make the mesh finer and finer." (Popper, 1980). Yet, regardless of how fine a net is cast, it seems to be the inherent nature of reality to remain forever beyond the means of researchers to find.

A theory and the body of 'laws' which it encapsulates is the result of imaginative formulation, testing, modification, more testing, and so on. This process produces theories which, in a limiting sense, approach the external reality sufficiently closely to produce results which are 'correct' to within the available experimental accuracy. Even if it were the case that a particular theory was identical with reality, it would be impossible to be aware of this fact. It would simply remain an unmodified theory, as it consistently produced results in agreement with experiment.

So if the 'laws of physics' are contingent, how or what is meant by the word — necessary? In formal logic, a necessary truth is one that is bound to be true, i.e. could not be false regardless of the structure of the universe. Logical tautologies such as "All bachelors are unmarried" are examples of this. (Hughes and Cresswell, 1977). Thus we are discussing necessity, but not logical necessity, for if this were the case we would be able to recognise the necessity by pure appeal to logical construction, as in the above example. If we are discussing whether a conclusion is to be necessary, then the criterion is that it must be the logical consequence of necessary premises. Our necessary premises are the structure of the universe or a fundamental part of that structure.

This brings us back full circle to the problem that we are unaware of what the structure of the universe actually is. Is the external reality. However, it may well be that we are being too pessimistic about what our theories can tell us. When it is considered that many present-day theories yield extremely good results when compared with experiment, this would tend to indicate that some of our approximations to reality are indeed close. In certain instances, there may be 'laws' which are so close to the real situation that the differences between the two are physically beyond our capabilities to ever perceive. Such 'laws' would have to be necessary.

A prime candidate for this honour would surely be the Second Law of Thermodynamics; Carathéodory's statement of which is "In the neighbourhood (however close) of any equilibrium state of a system of any number of thermodynamic co-ordinates, there exist states that cannot be reached (are inaccessible) by reversible adiabatic process." (Zemansky, 1968). The Second Law describes the existence of irreversible processes in the macroscopic world, and consequently is not fundamental in itself. It has, thus far, satisfied the usual a posteriori conditions in order to remain a 'law of physics', and the failure of mechanisms denoted 'perpetual motion machines of the second kind' is an apt example. Whereas it is true that each experimental verification of the Second Law adds to the strong argument for its retention, it would only take one counter-example to require either its modification or abandonment. So if it is to be considered necessary, then it must be shown to be so a priori. Here again, we strike the difficulty experienced in regard to our lack of absolute knowledge of the external reality.

Acknowledgement of this does not bring with it a dead end. Instead, let us use what tools we have available. These are what may be termed 'more fundamental processes', whose theoretical and empirical bases have been found sound time and time again. These processes, which are more fundamental than the 'law' being considered, approach the external reality as closely as possible under present experimental accuracy, and for the purposes of this discussion can be taken as being correct and necessary. This line of argument, a form of reductionism, will be used as an indicator of necessity of less fundamental 'laws', whilst we remain on-guard for any circularity.

In the example under consideration, the Second Law, the microscopic processes now take on importance. Let us consider a container divided into two by a diaphragm. A certain inert gas is piped into one half and a second inert gas into the other, then both sides are sealed. If we break the diaphragm, the gases will mix and after a certain time interval, there will be a uniform mixture of gases throughout. This system will then be in equilibrium when the mixing is complete, and its entropy will have increased from the value of the system before the diaphragm was broken. This process is described as "irreversible" on the macroscopic scale; however, microscopically the mixing is simply caused by large numbers of elastic collisions between the gas molecules themselves and their enclosure. Suppose we started with just one molecule of each gas, each on its own side, and then broke the diaphragm. After a time interval these two molecules will return to the positions within the container that they occupied before the diaphragm was broken.

This phenomenon is not restricted to two molecules, it can be extended to any number in a finite volume. The larger the number of molecules, the longer the time interval will be till the same positions are achieved again, and the smaller the probability of this event occurring. If the two regions of the container had sufficient numbers of molecules to exert atmospheric pressure say, the probability of their assuming their 'initial' positions is extremely small, corresponding to a time interval longer than the estimated age of the universe! (Denbigh, 1975, p.72). If we reason this way, we cannot a priori rule out this unlikely event happening, and its implications:
(1) over sufficiently long time intervals, the entropy of a closed system may decrease;
(2) states previously thought to be inaccessible are not so.

The foregoing contains the essence of the 'irreversibility objection' to the Second Law.

A suitable solution for the Second Law, due to K.G. Denbigh, is that the source causes of all irreversible phenomena are external to the particular system. In the example of the two enclosed gases, if one were to find them unmixed with the diaphragm broken, then there
would be two possibilities:
(1) It was set up that way by someone, and the diaphragm had just been broken;
(2) It was a highly improbable state of the system.

The first of these is a situation of an external cause. Irreversible reactions occur as a result of these (their boundary conditions), rather than the fundamental processes themselves. (Denbigh, 1975). All events have boundary conditions of some kind or other, and it is to these that we must look for our justification of a priori necessity.

Even if the effect of the boundary conditions is disputed, it is clear that no system (with the possible exception of the universe as a whole), maintains its identity as a closed individual over the time period required for its entropy to decrease, and the corresponding high probability intractable states to occur. The Second Law now follows logically from our premises, which we have taken to be (causally or otherwise) necessary, which requires the consequence (the Second Law) to also be necessary.

No argument such as this is ever quite complete, even taking its obvious limitations into account. It has attempted to demonstrate using the Second Law of thermodynamics as an example, that there are aspects of physics which can be examined in the light of whether there are or are not, compelling reasons other than the accepted empirical and theoretical bases, for regarding that aspect as necessary.

(The author wishes to express his appreciation to Dr. P. Reeper, who read the original paper and made valuable comments; and to Professor H.A. Buchdahl, who inspired it.)

References:

The only points of regret with respect to these volumes are the delay in publication — the conference was held in July 1981 — and the absence of an overview article in either volume. Such a retrospective analysis of the current main thrusts of research in this field would have been very worthwhile but no easy task for a collection of 78 papers by over 100 authors.

AUSTRALIA AND NUCLEAR WAR, M. Denborough (Ed.), Croom Helm Aust., Fishwick, ACT, 270 pp., $12.95 (paper).
Reviewed by B. Martin.

With the great expansion in the Australian peace movement and of media and public interest in war and peace, there is an enormous outpouring of materials about these issues. How is one to delve into the mountain of evidence and the many arguments? Reading this book is probably as good a way as any for gaining an initial overview on a range of perspectives.

The emphasis is mostly on Australia, and especially on the consequences of nuclear war for Australia. There are quite a few chapters treating technical issues, notably the ones on the atmospheric and medical effects of nuclear war and on the state of the arms race and its relevance to Australia. But the non-technical contributions, such as Nancy Shelley's discussion of the role of men and science in war, may well be more thought-provoking for scientists.

The strength of the book is its diversity, but its weakness is the lack of dialogue between the different views presented, for example concerning the likely attacks on Australia in the event of global nuclear war. There are also some gaps: while the economic and social impacts of arms and nuclear war are treated, there is no discussion of possible political upheavals.

Finally, what should be done about nuclear war? There are various recommendations from the different contributors, including education, influencing governments, nonviolent action, and self-examination. More than most academic contributions to the debate, this book has a chance of stimulating some form of active response.

Reviewed by P.A. Pearce, Research Schol of Physical Sciences, The Australian National University.

This monograph is number 30 in a well established...
series, Topics in Current Physics, devoted to critical reviews of subjects of current interest in fundamental physics. It aims to review the recent progress in real-space renormalization by focusing on some particularly significant developments that have taken place since 1976. This was the year of the landmark appearance of Volume 6 of the Domb and Green series, Phase Transitions and Critical Phenomena. The renormalization group approach to critical phenomena has been enormously successful over the last decade or so. Its basic ideas can be implemented either in momentum space, as was done originally by Wilson, or in real (position) space. The real-space methods incorporate Kadanoff's early ideas about block spins, they are conceptually simpler, and highly versatile and have flourished in recent years as this book attests.

The book Real-Space Renormalization consists of seven articles written by scientists who are leaders in their chosen areas. Topics included in the book are bonding and variational methods, Monte-Carlo renormalization, dynamic renormalization, quantum systems and applications to adsorbed systems, polymers and gels. Although the authors assume a familiarity with the fundamentals of the renormalization group, the articles are not addressed solely to specialists. For the most part, the articles are very readable and the subject matter is presented with a minimum of technical detail. The introductory overview by the editors Burkhardt and van Leeuwen particularly nicely sets Parallel the whole real-space renormalization group enterprise in perspective.

There is no doubt that this book is a must for all renormalization group practitioners. What is more, the book also represents good value for other readers wishing to know a little more about renormalization group methods in modern statistical mechanics, and with over 600 references, it offers an easy entry into the vast current literature on the subject.


Reviewed by D.R. McKenzie, School of Physics, The University of Sydney.

This monograph aims to provide a self-contained and comprehensive review of the field of thin film devices. It is intended to serve as a text for graduate students in applied science and engineering. It includes a reference for research workers in the field of thin film devices. It is a tall order indeed for a single volume and not surprisingly it has some shortcomings.

The book has eight chapters covering deposition methods, optical, optoelectronics, microelectronics, magnetic devices, quantum engineering applications, thermal devices and surface engineering applications. Such is the breadth of its coverage that in many parts it reads more like a dictionary of terms than a text book and unfortunately does not provide a great deal of insight into the physics involved in the devices. The book proved to be rather weak on all the topics I sought to assess it by. There is nothing useful in the book on amorphous semiconductors and liquid crystals and very little on the preparation and characterisation of films. Aging, reliability and life aspects of the devices are not discussed. The sections on solar cells and solar selective surfaces are tantalizing but lack substance. In both of these sections there are tables containing performance data but without reference to the literature.

Despite the shortcomings, the book will be useful for those who wish to broaden their knowledge in areas of thin film device applications with which they are not familiar. In this respect I found the section on magnetic devices interesting. Furthermore, the need for texts in this field which help to summarise the vast and proliferating literature is so great that this book will prove useful for many students and research workers.

COMBINED REVIEW


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

There has been a remarkable convergence over the past twenty years between the theoretical disciplines of quantum field theory and statistical mechanics. This is due to the fact that the Feynman path integral in field theory is essentially the same object as the partition function is statistical mechanics, once a transformation is made between a continuous Minkowski spacetime manifold on the one hand and (say) a discrete Euclidean lattice on the other. In each case, this object acts as a generating functional for the theory, from which all other quantities of interest can be derived.

Both of the books under review are examples of this trend. The first one consists of the Proceedings of the NATO Advanced Summer Institute on Theoretical Physics, 1981, in Freiburg, Germany. Its objective was a comparison of structures and methods between Elementary Particle Physics and Statistical Mechanics, and it contains several valuable reviews in both areas. For instance, H.E. Stanley reviews the treatment of critical phenomena, and illustrates the method by an excellent discussion of the percolation problem. J. Fröhlich outlines the recent proof of the surprising fact that the theory is trivial in 4 dimensions, and W. Nahm discusses the derivation of all self-dual multimonopole solutions for arbitrary gauge theories. Finally, there is a contribution on the Schrödinger representation from Prof. Kurt Symanzik, who was the first to recognize the correspondence between the Feynman path integral and the partition function referred to above. The recent death of Prof. Symanzik, at the sadly early age of 59, has robbed the field of one of its guiding spirits.

The second volume is a discussion of functional integral methods by Prof. V.N. Popov, who is well-known as one of the pioneers of path integral methods of quantization in field theories, and as a co-inventor of the “Faddeev-Popov ghost particles”. The book provides a lucid coverage of the quantization of quantum mechanical systems with constraints, of gauge field theories, and of the gravitational field; but it makes no attempt to deal with the renormalization of gauge theories. The bulk of the volume is taken up by applications of functional methods to particular physical problems ranging from plasma theory to the Ising model, and including chapters on superfluidity and superconductivity. It is marred by the occasional misprint, and by the rather stilted English of its translators, but is perfectly clear and readable nevertheless.

Both these books are for the specialist rather than the general reader, but they provide valuable additions to the literature in this field, and their inclusion is essential in any comprehensive reference collection.
Recent Theses in Physics

Infrared Studies of Stellar Populations
Robert Gordon Smith, Physics (RAAF) Department, University of Melbourne
Ph.D Degree conferred December 1983

The initial part of the thesis concerns results of the pioneer survey of the southern galactic equator by the Point Cook infrared telescope at 1.65 and 2.2 μm, in particular, it considers instrumental effects on the coverage and accuracy of the survey. Photometric observations of selected objects are used to confirm that unidentified sources in the survey are similar to those found by northern hemisphere surveys.

The work then turns to a detailed examination of the Carina nebula. Though not as famous a birthplace of stars as the Orion nebula, it has yet attracted much attention from southern optical and radio astronomers, and a complete review of observations since 1965 is made prior to a discussion of the 2.2 μm survey to ninth magnitude of the nebula’s centre.

The survey indicates a number of normal old red stars forming a background to a population of young luminous stars in two open clusters (Tr 14 and Tr 16), whose light has been greatly reddened. The background field stars are used to deduce the distribution of scattering material within and behind the nebula. The survey also found a number of more reddened early stars, which might be deeper in the dust, or yet younger members of the clusters.

A conclusion comes with the examination of the observed reddened spectral distribution, which is atypical in the direction of the clusters, and would seem to be caused by the destruction of smaller dust grains in these regions of the nebula.

Supervisor: J.A. Thomas

Rob is now working as an assistant astronomer at the NASA Infrared Telescope Facility in Hawaii.

Investigation of Laser Methods for Atmospheric Water Vapour Measurement.

Conferred: Dec. 1984

This thesis examines a number of methods of measurement of tropospheric water vapour profiles. Two new systems using the differential absorption (DIAL) technique in the near infrared are considered as well as one more conventional Raman scattered system designed specifically for very low altitude, high resolution profiles.

Calculations are presented for the requirements of a successful DIAL system operating in the 730 nm water vapour band. However, extensive attempts to produce a suitable laser source in this band, based on stimulated Raman scattering (SRS) were unsuccessful. The idea was to line-narrow and tune (within the normal Raman linewidth) the SRS output of a ruby-laser-pumped organic liquid in an SRS laser. These attempts were discontinued when it was found that the difficulty and complexity of this source was such that its use could not be justified when compared to proven dye laser sources at these wavelengths.

The second infrared system was successful and resulted in the development of a new water vapour DIAL system based on a Nd:glass laser transmitter. A widely-tunable narrow linewidth Nd:glass laser was developed which produced a single laser line of width less than 0.025 nm which could be tuned from 1053 to 1089 nm. This wavelength interval contains in excess of 100 water vapour lines and many of these at wavelengths beyond 1070 nm are suitable for long-path and range-resolved DIAL measurements. Equations have been developed for predicting the required transmitter energy for both range-resolved and long-path operation and these have been applied to the Nd:glass system. Long-path DIAL measurements are presented using a water line at 1079.96 nm which agree quite well with independent humidity measurements. Some very unusual effects were observed during scans in the region of 1074 nm which have important consequences for long-path DIAL measurements.

After a detailed feasibility study, which examined the special problems associated with profiling the sorts of structures associated with anomalous microwave propagation on terrestrial communications links, a Raman lidar was constructed and reasonable agreement obtained between calculations and experimental results. Absolute mixing ratio calibration can only be obtained with the Raman lidar after careful calibration against another water vapour measurement system.

Supervisor: Dr. Ian Bourne

Electron Density Distributions in Crystalline Rare Earth Complexes

Ajay Chatterjee, Department of Physics, University of Western Australia.
Ph.D Conferred 1984

The deformation of the rare earth metals’ electron density due to chemical bonding was studied by analysis of x-ray diffraction data for eleven members of an isomorphous series of rare earth complexes (the nonaquialanthanoid 3+ ions). The structures were first refined using data collected at room temperature, and difference density maps were evaluated. The effects of thermal anharmonicity were assessed by a neutron diffraction analysis for the neodymium member of the series.

The deformation density maps for the lighter members of the series are topologically equivalent. Features near the metal nucleus in these maps are predominantly due to a fifth order multipole term with the rotational symmetry of a 4f-5d product. The features further from the nucleus cannot be described efficiently in terms of such products. Low symmetry components correspond to a crystal field which is complicated enough to form, reflecting, among other factors, the effect of hydrogen bond links to the ligating water molecules in the nonaquialanthanoid 3+ ions.

The lanthanide contraction for the series of rare earth metals is anisotropic. The bond-lengths to the oxygen atoms at the prism positions in the tri-capped trigonal prism surrounding the metal change more rapidly than those to the equatorial oxygens. The polarisation of the density near the metal increases rapidly as the f shell approaches the filled condition, and is stronger along the longer metal-oxygen bonds. The orientations of the prism water molecules are irregular. The ligating water molecules for the longer equatorial bonds have a trigonal orientation, with the symmetry axes for the isolated water molecule pointing at the metal atom. The electron density near the metal atom along the line of the metal-
Electron Microscope Study of New and Disordered Crystal Structures
By G. Grzinic, School of Physics, University of Melbourne.
Ph.D Awarded 1983

The calculation of diffraction intensities from disordered crystals has been reformulated in such a way that the general features of both commensurate and incommensurate superlattice diffraction patterns may be understood readily. Crystallographic disorder (in 1, 2, or 3 dimensions) may be calculated by defining an appropriate set of sub-cells which are then allowed to mix, or intergrow coherently, in specified proportions. Use of high-resolution electron microscope (HREM) images, to derive appropriate sub-cell structures, allows realistic statistical descriptions of the disorder. Computer simulated diffraction patterns have been obtained for specific classes of disorder, which show excellent agreement with experimental data.

Applications included firstly, the well known cases of stacking faults in close-packed structures and antiphase boundaries in binary alloys. Secondly, applications to novel disordered structures are considered, including the one-dimensional incommensurate superlattices due to alkali cation occupancy on hollandite-type structures and the two-dimensional incommensurate ordering in Ba$_2$TiO$_5$.

The thesis also includes chapters on HREM study of incommensurate superlattices of the hollandites Ba$_{2}$Ti$_{5}$Mg(O$_{2}$)$_{4}$, and Ba$_{2}$Ti$_{6}$Ga$_{4}$O$_{15}$, which reveals directly the nature of short-range order for the Ba-ion sites, and the direct determination of the complex crystal structure of Ba$_2$TiO$_5$, using HREM imaging and computer-simulated image-matching techniques.

Supervisor: L.A. Bursill.

Pulsating stars with ultra-short periods
T.T. Moon Physics Department, Monash University.

Design and construction of astronomical equipment for photoelectric photometry of stars is described along with the techniques of acquisition, reduction and analysis used to process the data obtained. Current theories of stellar evolution are expounded. Discussion of pulsation in stars and the theoretical aspects of stellar structure and evolution are restricted to areas relevant to an understanding or interpretation of Ultra Short Period Cepheids, USPC's (also called Scuti and RRs stars).

A compilation of data for 183 known USPC's is given and the observational particulars of this class of variable stars are reviewed. Seven known USPC's were reobserved; these new observations are presented and their implications discussed.

The results of a survey for new USPC's at southern declinations are reported and two newly-discovered USPC type variable stars described. Finally, further research is considered and preliminary results for a program to monitor variations of 'red variables' are reported.

Supervisors: Dr D.W. Coates and Dr K. Thompson.

Observations and Analysis of some short period variable stars
L. Halprin, Physics Department, Monash University.
Ph.D awarded 1984.

Two different types of short period variable star were observed photometrically using the 41 cm newtonian telescope at the Monash University observatory. The ultra short period pulsating star, SX Phe, represents a group of intrinsic variables which do not conform with the majority of the short period pulsating variables. SX Phe was found to be undergoing period changes; the rate of change of the fundamental period was measured as $(10.5 - 7) \times 10^{-13}$, which is in agreement with the theoretical value calculated by Dziembowski and Kozlowski (1974) who assumed a mass of the order of 0.2M$_{\odot}$ for SX Phe. This, along with evidence of low metallicity and extreme space velocity probably means that SX Phe is an old Population II star (unlike the Delta Scuti variables). The method presented in this thesis for detecting the changes in both the fundamental and overtone periods of SX Phe may be applied to the observations of any short period multiperiodic variable star whose light curve exhibits a significant brightness phenomenon.

The eclipsing binary system HD 5303 is confirmed as a member of the RS Canum Venaticorum group of close binary stars. HD 5303 was observed at Monash as part of a program to search for southern RS CVn systems. Results for several of these stars are presented. From these data it is likely that the candidate HD 174429 is a noneclipsing RS CVn system.

The discrete Fourier transform (DFT) was investigated as a means of searching for periodicities in astronomical observations which are unevenly spaced in time. As a result of this study the FORTRAN package of DFT programs was developed for general use with data such as these. The programs were tested using published data from the short period pulsating variable CY Aquarii. An alternative period analysis technique, the Maximum Entropy Method, was examined briefly using data interpolated from a single night's observations of SX Phe, and the improvement in spectral resolution as compared to the discrete Fourier transform was noted.

Supervisors: Dr D.W. Coates and Dr K. Thompson.

Direct Electron and Ion Fluid Computation of High Electrostatic Fields in Dense Inhomogeneous Plasmas with Subsequent Nonlinear Optical and Dynamical Laser Interaction
Paraskevas Lalouisis, Department of Theoretical Physics/School of Physics, University of New South Wales.
Ph.D Awarded April 1984.

The motivation of this thesis was to study the nonthermal direct electrodynamic interaction between laser energy and a fully ionized plasma. The particular emphasis is on the action of the nonlinear (ponderomotive) forces, in which the optical electromagnetic fields act on the plasma electrons which then transfer their energy to the ions electrostatically. The usual single fluid model, the plasma is treated as two separate conducting fluids for electrons and ions, coupled by momentum and Coulomb interactions. Hence no steady-state conditions are assumed; the electrostatic fields are derived from Poisson's equation in a dynamically changing state.

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The equations governing the two fluids are derived from first principles, and numerical algorithms for computing these equations are developed, enabling the plasma oscillations to be resolved and studied.

Fully ionized plasma expansion without laser irradiation is studied first numerically. Remarkable damping mechanisms by coupling to ion oscillations have been observed. Inhomogeneities in densities of the two fluids result in large electrostatic fields and double layers are generated. There is quite close agreement between numerically calculated electrostatic fields and analytical solutions. It follows that any inhomogeneous plasma contains electrostatic fields determined by the pressure gradient. ("inhomogeneity fields").

Laser interaction with fully ionized plasma is also studied numerically. The laser radiation acts in two ways:

(i) thermal absorption of the laser radiation increases the electron temperature and subsequently the ion temperature through equipartition, and

(ii) non-linear forces transfer optical energy directly into mechanical energy of the plasma electrons which then transfer mechanical energy to ions electrostatically.

The generation of cavities is numerically observed, and it is inferred that laser plasma interactions produce very high electrostatic fields in the vicinity of cavities. It is further shown that charge neutrality is not necessarily maintained in a caviton.

Supervisor: H. Hora

PUBLICATIONS:
First direct electron and ion fluid computation of high electrostatic fields in dense inhomogeneous plasmas with subsequent laser interactions by P.L. Laloumis and H. Hora, Laser and Particle Beams 1, 283 — 304 (1983).


PRESENT ADDRESS:
Euratom — Postdoctoral Fellow, Max-Planck-Institute for Plasma Physics, 8046 Garching, Germany -W.

Canberra — In Brief

- The Opposition parties have released a new industry and science and technology policy. Key features of this policy and tax incentives for research and development, grants for setting up CAD/CAM systems, accelerated depreciation rates for spending on flexible manufacturing systems and retention of the investment allowance. Under its industry policy the Opposition promises to provide a grant of up to $20,000 or seventy-five percent, whichever is the lesser, towards the cost of identifying the need and setting up CAD/CAM systems in industry. Industrial research and development would be encouraged through a new tax incentive scheme allowing a fifty percent write-off for all spending by industry on research and development. The opposition policy rejects the idea of picking winners for support and emphasises that commercial decisions on products and research must be left to industry and market forces. The policy says it aims to use science and technology to boost productivity and international competitiveness, to encourage industry to spend much more on research and development and to raise the community awareness of the effects of new technology.

- The Minister for Industry and Commerce, Senator Button, released in August new Government measures to encourage the aerospace industry. This found further the development of a space technology base in Australia.

- A team of OECD examiners have recently finished a two week investigation of Australia's science and technology policy. The OECD has been asked to advise on the direction of Australia's policies to help revitalise existing industry, develop new enterprises and strengthen present scientific and technological capabilities.

- A full bench of the High Court, in a landmark decision, has upheld the right of union wards to contain clauses requiring employers to consult on technological change. Five judges rejected submissions by employer groups that technological change was not an industrial matter because it did not relate to conditions of employment.

- A Commission for the Future is to be established later this year following a strong campaign for Budget funding by the Minister for Science and Technology. The Commission for the Future will draw up scenarios ten, twenty or even thirty years into the future. The aim is to raise public awareness and debate about technological change and present the community with a range of options from which they can make their own informed choice on the future directions.

- A twelve member National Taskforce on Education and Technology has been established under the Chairmanship of the South Australian Minister for Education and Technology, Mr Lynn Arnold. The taskforce will examine the relevance of subjects taught in pre-school through to tertiary levels to determine whether the education system is responding to demands of rapid technological change.

- The Department of Science and Technology in conjunction with consultants W D Scott and Company have recently released the findings of a major study into information technology in Australia. The three volume report which marks the completion of more than a year's research in analysis in Australia and overseas found that Australia must become an active user in information technology; strong opportunities exist for developing local industry, and the industry must have a strong export orientation and focus on specialty product market areas. The consultants recommended a detailed action plan that would cost the industry and the Government about $170 million over the next five years. The Department of Science and Technology has so far received only a limited response to the release of the Scott Report on information technology and it is hoping that more groups will respond to the document.

- The CSIRO budget is discussed elsewhere in this time and in the October issue.

AIP Science Policy Committee
PEOPLE

Mr D.M.W. Powers, BSc Syd., has been appointed Lecturer in Computing, School of Mathematics and Physics at Macquarie University.

Mr. J.R. Kyte, BE N.S.W., has been appointed Professional Officer, in the same school. He was previously Assistant Manager, Engineers Branch, Housing Commission of New South Wales.

* * *

Glaciologist Trevor Hamley who spent last summer with a Soviet expedition arrived back in Fremantle in April on board the vessel "Baikal". He completed a 3,000 km round-trip traverse to Dome C (74°40'S, 132°50'E) returned to Mirny. Main work carried out on the journey was the remeasurement of the position of ice movement markers established on the route by Australian glaciologists in four previous summers. This work, together with measurements of snow accumulation and other observations en route provide important information on the ice sheet of inland Antarctica.

* * *

Dr. Phillip Law has been appointed to the Antarctic Names and Polar Medals Committee of Australia. Purpose of the Committee is to recommend to the Minister for Science and Technology names for features in the Australian Antarctic Territory and Heard Island, and persons who are to receive the Polar Medal, the highest award given to Antarctic personnel.

* * *

Of the 107 members of the Australian wintering expedition in 1984 8% (10) are involved in research work, a figure which drops to 6.5% if one discounts the three scientists from the People's Republic of China. Research is being carried out in the fields of Upper atmosphere physics, geology, biology and glaciology. In addition to those engaged in research programs a further 19% (20) of wintering parties maintain routine observations in the fields of geophysics, ionospheric physics, cosmic ray physics and meteorology. Observations recorded are used by investigators in a world-wide range of research programs.

* * *

Fred Bond, former head of the Antarctic Division's Upper-Atmosphere Physics Section is currently engaged in preparing a history of physics research carried out at the Division since 1948. Fred retired from the Division in January last year after over twenty-five years service with the organisation. In his retirement he has continued researching and writing papers.

Service to the University Acknowledged

Macquarie University Council conferred the title of Emeritus Professor on Professor John Clive Ward, Professor of Physics, in recognition of his contribution to scholarship and learning, and of his service to the University.

In a tribute to Professor Ward, the Vice-Chancellor said he would remain a valued and perceptive colleague "in whose eminence the University will continue to be able to share and from whose knowledge the University will continue to benefit."

Professor Ward has international recognition for his work on quantum field theory. He was elected Fellow of the Royal Society in 1963 and was awarded the 1983 Hughes Medal of the Royal Society "in recognition of his highly influential and original contributions to quantum field theory, particularly the Ward identity and the Salem-Ward theory of weak interactions."

The Vice-Chancellor described Professor Ward as a vigorous advocate of the importance of teaching, particularly of useful science, which he contrasted with the theoretical topics beyond the capability of most students.

"Professor Ward taught at all levels of undergraduate courses and postgraduate programs. He saw the necessity to influence the teaching of Physics in the secondary schools. Together with the late Professor R.E.B. Makinson, he developed the Special Masters Program for Science Teachers. In the 1970s he established a Centre for Teaching Resources in Physics Education at the University."

"Professor Ward's emphasis on relevant science led him to press for the development of teaching in electronics. During his term as Head of the School of Mathematics and Physics (1971-73), a Chair of Electronics was established. The presence of electronics greatly enriched physics teaching and research."

Macquarie University News

* * *

After reading in Co Research about the car built by Lindsay Derriman which competed in the Shell Mileage Marathon last year, Graham Allen from the Division of Applied Physics in Sydney decided to enter a car in this year's event.

His car came second in the Private Entry Class with a fuel consumption of 1236 miles per gallon, and won the trophy for the most outstanding inaugural entry.

The tear-drop shaped car, named "Glider Possum", was designed and built by Graham Allen and John Storey, with assistance from Phillip Lennox, also of the Division and Graham's father, Roy. It was driven by his sister, Michelle Allen.

Construction took three months of late nights and weekends and was done in the spare room of Graham's home.

The car has a fibreglass and carbon fibre monocoque bodichassis and weighs 22 kg. It has a 15cc air cooled 4 stroke model aeroplane engine converted to spark ignition, which drives the single rear wheel via chain and sprockets.

The Mileage Marathon was again won by the Ford Motor Company team from Geelong. In a dramatic last minute attempt their car achieved 3133 mpg, breaking their own world record of 2940 mpg set at last year's event.

Lindsay Derriman, who last year won the Private Entry Class and the Australian Automobile Racing Club Trophy for Ingenuity and Enterprise, had a run of bad luck this year. He took two cars to Sydney from Perth, but one's motor failed while the other's gear box failed.

However, undaunted, he is 'definitely' making the long trek from the west again next year, and will be joined by Graham Allen and his team and some other CSIRO inventors...?
New Chief

The new Chief of the CSIRO Division of Textile Physics, Dr Ken Whiteley will expand the Division's wool research and apply the techniques to fibres generally.

Dr Whiteley said that although the Division's work would stay closely related to wool, it will move into related areas, such as particles and fabric filtration.

He is interested in the removal of particulate matter and especially its application in industry.

The Division also intends to forge closer links with manufacturing industries other than wool.

Dr Ken Whiteley, who is well known internationally, became the Chief of the Division of Textile Physics after Dr Robert Haly retired on June 1.

He joined CSIRO in 1980 as a senior principal research scientist at the Division. He has had a distinguished career since completing his doctorate in textile chemistry at the University of Leeds in 1959. He was an associate professor in fibre science at the University of NSW from 1976 to 1980.

Dr Whiteley's research interests include fabric performance and aesthetics, raw wool metrology and fleece characteristics.

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The University of Sydney's Professor of Nuclear Physics, Professor Brian McCusker, has given two talks on the ABC on his controversial views on recent developments in Physics.

Professor McCusker, who maintains that the principles of Quantum Mechanics lend great support to the validity of psychic phenomena, such as levitation, ESP and even Tarot cards, spoke on "The Demise of Atomism" and "The Future of Science".

***

Dr Harry Atkinson, formerly of Nelson, has been appointed chairman of the European Space Agency Council for two years. He was appointed Science Director of Britain's Science and Engineering Research Council last September, and has been a British delegate to the Agency Council since 1973, serving as its vice-chairman since 1981. Dr Atkinson was educated at Nelson College, the University of Canterbury and Cambridge University.

***

B J Thompson has been appointed Provost of the University of Rochester, New York, USA. Dr Thompson joined the university in 1968 as Director of its Institute of Optics and Professor of Optics, and has served as Dean of the College of Engineering there since 1975. He has worked in the fields of coherent optics, holography, phase microscopy and image processing, and he was responsible for the development of the dynamic particle size analysis technique which is now used in a variety of fields.

Dr Thompson is a graduate of Manchester University. He has served on the editorial boards of many international journals, and has been active in various US national and international scientific organisations. He is also a consultant to such companies as General Motors, Leeds and Northrup, and Allied Chemical Corporation.

Poet Laureate of Britain Sir John Betjeman found an unlocked display case in the Geological Museum (London). He placed inside it a conker (horse chestnut) with a label saying "Chestnut, donated by J. Betjeman Esquire". Exhibit and label lay undisturbed for several years. Could this happen at your museum?

New Award for Work on Electromagnetic Launchers

A new medal named in honor of the late Peter Mark has been established to recognize work on electromagnetic launch technology (see PHYSICS TODAY, December 1980, page 19). The first recipients included Richard Marshall (Australian National University) and Henry Kolm (EML Research and MIT).

A third medal was given to Mark's widow on his behalf. The medals were presented at a symposium on electromagnetic launch technology sponsored by the Defense Advanced Research Projects Agency and the Institute of Electrical and Electronic Engineers.

Marshall, an electrical engineer, received the medal for a number of contributions to the design of homopolar generators and railguns. For example, he developed the high-current density brushes for the world's largest homopolar generators, in Canberra.

Kolm is one of the cofounders of the Francis Bitter National Magnet Laboratory at MIT. He is being honoured for his pioneering work in coaxial synchronous launchers. In addition to his research —
which has involved cryogenics, magnetic separation, piezoelectric devices and magnetic levitation in addition to his work on electromagnetic launch technology — Kilm has started EML Research to develop the hardware for electromagnetic launch technology.

K.D. Cole of La Trobe University, Melbourne, Australia, has been awarded the 1984 Appleton prize for ionospheric physics, in recognition of his distinguished contributions to understanding the fundamental processes in the magnetosphere and ionosphere. The award is made triennially and the recipient is selected by the Council of the Royal Society in consultation with the Board of Officers of the International Union of Radio Science. Professor Cole has been active in his area of research since the early 1960s.

After more than 45 years’ service Mr Les Valentine is retiring from the Division of Applied Physics’ Clayton laboratories. He joined the Munitions Supply Laboratory in 1939, where he was involved in gauges and length standards, and joined CSIRO in 1979 when the force and pressure standards group of the Materials Research Laboratories transferred to Applied Physics.

Mr Charles Franchimond, who joined CSIRO 24 years ago, has retired from the power frequency group at the Division of Applied Physics. His work has been mainly involved with the calibration and testing of a-c-d converter instruments and in the development of a-c-d transfer standards. He has also researched and developed metal converters as transfer standards and has contributed to the development of a new method for determining errors in such devices.

Mr Ron Ballantyne, a specialist in architectural physics, has retired from the Division of Building Research but has remained as the Division’s first post-retirement fellow.

Omkar Sharma, from the National Physical Laboratory in New Delhi, is being sponsored by ADAB to spend three months at the National Measurements Laboratory and study acoustic measurement as practised at NML. The two laboratories have already collaborated in a “round robin” microphone calibration exercise conducted as part of the Asia Pacific Metrology program, and NML would like to extend this service to cover the full audio frequency range.

Dr Stephen Collocott, from the Division of Applied Physics, is spending seven months overseas attending conferences in Europe, visiting laboratories and working at the Clarendon Laboratory at Oxford on low temperature materials research.

Mr Roger Morse, AO, has recently accepted the first Honorary Research Fellowship to be offered by the Division of Energy Technology. He will pursue his research interests in the development of solar air heaters and take part in general scientific debate within the Division. The 12 month period begins in September.

Dr D. Doornbos of the Royal Norwegian Council for Scientific and Industrial Research — Norwegian Seismic Array (NTNF/NORSAR), is visiting the Physics Department, University of Queensland, from July to December 1984. Activities/interests: Seismology and physics of earth’s deep interior. Contact: extension 3409.

**BRANCH NEWS**

**Victoria**

(We must apologise to our Victorian friends for the delay in appearance of this report. The material is still timely. Ed.)

Report on ‘A Crisis in Science Education’

The Australian Institute of Physics, the Australian Mathematical Society, and the Royal Australian Chemical Institute combined forces to hold a one-day seminar ‘A Crisis in Science Education — the Interface between Secondary and Tertiary Education in the Physical Sciences’ at La Trobe University on 24 February. The seminar, which attracted approximately 90 participants, covered a comprehensive programme and included addresses by senior personnel from the Department of Education, the Victorian Institute of Secondary Education (VISE), the Victorian Secondary Teachers’ Association (VSTA), the Science Teachers’ Association of Victoria (STAV), and the tertiary sector. During the course of the day it became clear that there were three views of the interface, the tertiary, the secondary and the political.

Following the opening remarks of Dr R. Leckey, Chairman, Victorian Branch AIP, Mr R.G. Ritchie, Executive Director (Personnel and Resources) Victorian Education Department presented the first address. Mr Ritchie’s comments were largely in accord with the views expressed in the report ‘Participation and Equity in Australian Schools: the Goal of Full Secondary Education’ prepared for Senator Ryan by the Commonwealth Schools Commission. Broadly speaking, the Department’s emphasis was to be directed towards a greater participation of all students in secondary education, with the adaptation of schools to local needs and less emphasis on specialist preparation for tertiary education.

Mr Ritchie placed the responsibility for the crisis with the tertiary side of the interface, pointing out that changes had occurred in the pre-tertiary area that the tertiary sector had failed to respond to. Notably, tertiary bodies should not expect to dictate school curricula, nor
lay down rules for entry and should be more flexible in their selection of students. This was the general theme, with variations, that was repeated during the day by Dr C. Malcolm (Education Department) and VISE representatives Mr B. Rechter and Mr M. Copley and secondary sector representative Dr M. Stevens (Mathematical Association of Victoria).

The representatives from the secondary area, Mr P.J. Noyce (VISTA) and Mr D. O'Keefe (STAV), were understandably concerned by the problems faced by the secondary school teacher in making science attractive and relevant to the overall student population and yet meeting the more specific goals for entrance to the tertiary sector. Both speakers highlighted the lack of interest of girls in taking science and the poor representation of women in science, a situation which was reinforced by the absence of a female speaker at the seminar from any area. Using comprehensive statistics, Mr O'Keefe drew attention to the dramatic increase in Year 12 population, yet the number of students taking science remained relatively constant.

Concern over the poor level of preparation of tertiary studies provided by the secondary sector, was a common theme with the speakers from the tertiary area. The opening speaker from the tertiary sector, Professor J.I. O'Hare (School of Physics, University of Melbourne), emphasised the poor preparation of science teachers and the lack of appropriately qualified science teachers. He also urged the tertiary sector not to dwell on the past and to recognise the changes that have already occurred in secondary education and to make an effort to provide more constructive input into secondary science teaching particularly with respect to syllabus formulation. Dr J. Cross (Department of Mathematics, University of Melbourne) and Dr I. McWilliam (Department of Chemistry, Swinburne Institute of Technology) advocated a more elitist approach, deploring the lack of rigour in the secondary preparation of students of tertiary studies. Dr I. Dickson (Department of Environmental Science, Victoria College (Rusden)) provided startling evidence of the poor quality of the preparation for entry to tertiary education experienced at Rusden and described the bridging-type course that has been introduced to contend with it.

The most alarming statistics of the day were presented by Dr T.M. Kalotas (Physics Department, La Trobe University) in his review of the educational scene in the United State of America. The decline in skills in numeracy and literacy, the cafeteria style education with no major theme, "broad based" social subjects and the strong decline in the popularity of science and mathematics are now matters of great concern for the National Commission of Excellence in Education, the majority of members of which are from the secondary area. Is this the future for Victorian education?

There could be no doubt at the end of the day that a crisis does exist at the interface between secondary and tertiary education. On the one hand, the universities, in particular, conscious of their responsibility as custodians of Australia's international recognition for the quality of its scholarship are concerned with the maintenance of intellectual standards, whereas, the secondary educationists are faced with the equally important task of providing equality in education for the benefit of all. Adopting hardline policies on either side of the interface in the long run can only be to the detriment of both secondary and tertiary participation in the students suffering the most. It is to be hoped that this seminar, in highlighting the problems involved, will lead to a more constructive interaction between the members of both sectors.

T.F. Smith

W.A.

Professor Peter D. Dunn, Department of Engineering, Reading University, who had been giving the opening keynote address to the Sixth National Congress of the A.I.P., returned home via Perth. He reported on the Teaching and Implementation of Alternative Technology to Non Industrialised Nations. His message was very clear:

First, carefully investigate the problem by visiting the country and enlisting the local population in the solution of the problem. Then to overcome the problem, the appropriate technology must be designed so that the local population will be able to use it and have the necessary resources to keep it in good repair. To this end Prof. Dunn has now established a course at Reading University where overseas science students may take an M.Sc. degree. After training they go home and pass on their knowledge. The course costs £4,500 and is paid by the student's country. This makes the program independent of British government finance.

Prof. Dunn showed us many interesting examples of this appropriate technology. His enthusiasm was very infectious and hopefully some members of the A.I.P. and visitors from the Department of Mechanical Engineering in W.A. and APACE have caught "the bug".

Careers Information Evening

This annual event was organized by Superintendent K. Brehaut and Dr. P. Rye. 50 undergraduates attended. The Chairman was Peter Page and the following topics were discussed:

Ron Price (WAIT) "Consultancy". Opportunities exist for physics consultancy, but almost entirely on a part time basis. Numerous small (i.e. "one professional") companies subcontract out tasks within the physics domain. Some opportunities exist, even at an undergraduate level, for assistance in WAIT AID projects.

Richard Fox (RPH) "Medical Physics". The large range of activities includes the various diagnostic areas:— X-ray, ultrasound, nuclear and NMR imaging. Overall, the picture is exciting, with newer technologies requiring physicists. He advises students, who intend to enter medical physics, to complete an Hons. degree in Physics and do postgraduate work in the hospital environment rather than in a physics department.

Peter Dallimore "Patents Office". There are openings for physicists in the Patents Office. The work is interesting in the manner typical of the public service, and the government is anxious to help stimulate small companies with bright ideas. In fact there is no shortage of money in Australia to support innovations — only a shortage of good ideas!

Geoff Hawke "Teaching Opportunities". There is currently a shortage of science teachers. He advises broadly based degrees, since a physics teacher will also end up teaching chemistry, biology or geology. A Dip. Ed. is essential.

Peter Cornish from the Professional Employment Service talked about requirements of an interviewee.

The meeting closed with a panel discussion which lasted for 30 minutes with lively questions from the floor.

Trudi Thompson
Dear Sir,

The Editorial in the Australian Physicist for September 81 makes mention of a visit to China by members of ASIA. (Australian Scientific Instrument Association). The correct name for the organizations is the Australian Scientific Industry Association.

While the Association was primarily developed "for all persons, bodies, organizations and companies with an interest in scientific instruments or equipment..." it serves a wider need in promoting information and technology transfer between industry, government and higher education institutions. The Association serves as an interface between researchers, marketers, manufacturers, inventors and consumers.

The overall aim of ASIA is to determine the needs and aspirations of its members and pursue these, to exploit the undoubted quality of local innovation and manufacture for the benefit of the scientific industry in Australia.

A West Australian branch of ASIA was commenced in 1983 and holds seminars and meetings at frequent intervals.

Peter Murphy
The Secretary

Dear Sir,

As convenor of the major symposium on Nuclear Arms at the ANZAS Congress held earlier this year, I feel that I must reply to the letter by Ms Vivienne Colless (The Australian Physicist Vol 21 No 8, September 1984, p. 176). I am gratified by her general approval of the debate on the vital issues involved in the nuclear arms race. The symposium was planned by a small working party, which included Dr Julie Dahlitz. We were very conscious of the desirability of participation by women and the first session included talks by Ms Petra Kelly and Dr Julie Dahlitz.

I chaired the second session and Ms Colless expresses disappointment that I did not invite a woman to present a short address on the importance to women of Australia's role in the nuclear arms race. Notification was given in the final circular and at the first session that "Participants wishing to make short contributions up to five minutes are invited to let the Chairman know in advance giving keywords to allow the discussion to be somewhat structured." Five men and no women (!) responded to this invitation before the start of the second session and in the event I was only able to call on three of these to speak. In fairness to the other two, I did not feel I could invite a woman to present a new theme into a crowded session nearing its close. I still do not see how I could have decided otherwise, and so am quite unperturbed! However, I do applaud the role of women in activities such as "Sound Women's Peace Actions" and wish the women concerned every success in eliminating Australia's participation in the nuclear arms race.

Alan Runciman
Professor of Solid State Physics, Australian National University.

Dear Sir,

I attach a copy of a letter sent to the Prime Minister, Ministers of Education & Youth Affairs; Science and Technology; Industry & Commerce and the Leader of the Opposition.

J.D. Whitehead
Professor in Physics
University of Queensland

Dear Prime Minister,

At the meeting of the Heads of Physics Departments of Australian Universities and Institutes of Technology (or their representatives), the following motion was passed —

QUOTE

- Physics is one of the fundamental disciplines which underpin science and technology.
- Discoveries in physics, which cannot always be predicted, do in due course affect the evolution of science and technology, and this in turn affects the development of society.
- The Universities and Institutes of Technology produce a large fraction of the total amount of research in Australia.
- New developments in physics in the Universities and Institutes of Technology in Australia have led to new technology, e.g.
  (i) Low temperature technology from research on gravitational waves;
  (ii) Microelectronics from materials science;
  (iii) Meteorological radar from upper atmosphere physics;
  (iv) Infra-red detectors from astronomy;
  (v) Solar energy from surface physics.
- Demand for higher degree graduates in physics exceeds supply. This is regrettable in this era of a technologically based society.
- The graduates of research programmes in the Universities go on to be leaders in research fields not only in Australia but throughout the world. However, since 1978 there has been a severe decline in the support of physics research in the Universities from their internal funds in the following areas —
  (i) Technical positions;

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the Research Performance of the Australian University Physics Departments” (The Australian Physicist, Vol. 21, No. 3, p.58) he claims that the physicists at Murdoch did not constitute a department as there were only three of them in 1982.

While it is true that Physics at Murdoch is not organised into a traditional department but into a Programme within the School of Mathematical and Physical Sciences, there were in fact seven members of the academic staff in Physics in 1982. Of these, four were tenured positions (lecturer and above), the fourth position being added in 1982 and a fifth in 1983.

Comparing the performance in publication in the period 1980-1982, the average output of papers per staff member was 5.0 at Murdoch, placing it fifth on Campbell and Campbell’s table (p.59). I therefore fail to see why our efforts at research were completely disregarded by Campbell and Campbell simply because they could not conceive us as being a department.

Dr. S. Thurgate
Physics Programme Chairman.
Murdoch University.

PHYSICS ROUNDBOUGHT

A hand-held magnetic flux meter

The Arlunya Division of the Dindima Group Pty Ltd, an Australian hi-tech company that is competing successfully on international markets with its range of real time, digital, image-processing systems, is also marketing a portable device for measuring magnetic flux.

Just as the Arlunya image processors provide noise reduction with improved contrast and brightness of stored images, the magnetic flux meter, dubbed Gauss Mau, has been designed for a related task which is to detect small AC magnetic fields that affect the resolution and clarity of images on the latest generation of transmission electron microscopes (TEMs).

Detail down to atomic level (around 0.15-0.2 nanometres) can be detected with these super TEMs.

The CSIRO Division of Chemical Physics is using such an instrument, a JEOL 200CX, for a broad range of investigations including the computer analysis and evaluation of crystal lattice images of materials such as copper arsenic selenides doped with germanium.

However, the results obtained at this level of resolution are critically dependent on the adjustment of illumination in the TEM. They are possible only if the instrument can be shielded from very small magnetic fields, i.e. less than 1 milligauss.

A typical problem arises when someone turns on a fluorescent light in an adjacent room (the inductor in the fluorescent fitting is a source of magnetic interference). This could greatly impair the quality of the image on the screen of the TEM. Similarly, nearby equipment such as resistive furnaces and electric heaters are other possible sources of magnetic interference. Even hot water service plumbing can be a source of such interference through earth leakages.

And so, the Division decided that it needed a magnetic flux meter to detect interference sources of these kinds when it installed the JEOL 200CX-TEM 2 years ago.

Unfortunately, there were no suitable commercial types available, except for instruments costing around $4000, which were not portable.

The Division then set about the task of designing a cheap, portable device that would detect magnetic fields down to about 1 mG in industrial and research environments.

The objective was to produce a device that would become an essential accessory for all instruments and equipment affected by external AC magnetic fields, e.g. cold emission analytical scanners and computers, as well as TEMs. The result was an analogue instrument that enabled the Division to improve TEM image quality significantly. Arlunya further developed this concept and produced its commercial Gauss Mau. The ergonomically designed device is easy to use. The operator holds the digital readout meter in one hand and with the other moves the transducer unit around to pinpoint sources of AC magnetic fields.

The Gauss Mau has ranges of 0-10 and 0-100 mG which are selected by switches. It can be set to detect 50 Hz or 60 Hz interference fields by internal slide switch, and so is suitable for use in most countries.

An oscilloscope output is provided to allow observation and further analysis of interfering fields. The Gauss Mau sells for $380.

Cosmic Rays

The Adelaide University’s Physics Department has a Cosmic Ray Air Shower Array at Buckland Park, a University research station, near Two Wells, north of Adelaide. The Air Shower Array consists of 27 transparent plastic detectors which emit small amounts of light when radiation passes through them. The detectors are housed in light proof enclosures inside sheds located at predetermined intervals over an open field. These observations are relayed to a central computer at the facility.

Most of the air showers are caused by atomic nuclei and much of the effort over the last ten years has been spent on determining the type of nuclei involved. This
has involved use of the array as well as special detectors observing the faint light emitted as Cerenkov radiation by extensive air showers in the atmosphere. Over forty publications have resulted from this work which has been carried out by Professor John Prescott, Dr Alan Gregory, Dr John Patterson, Dr Roger Clay and their students.

The facility was established in 1972 by Professor Prescott. Over the past two years the number of detectors has been increased from 11 to the present 27, at a cost of $97,400. Funds were provided by the University and the Australian Research Grants Scheme for the expansion of the facility. According to Dr John Patterson, Senior Lecturer in Physics, the increase in the number of detectors will give greater directional accuracy and reduce observation times.

"Rather than waiting for twenty years we will now be able to obtain the same amount of information in two", he said.

The Cosmic Ray Air Shower Array is now better able to sample the large number of particles contained in a shower as they hit the earth's surface. This allows a more accurate calculation to be made of the total number of particles in the shower, which is a measure of the energy of the primary particle or cosmic ray. The additional detectors will also enable many smaller showers to be observed.

The accuracy of the array in determining the directions of cosmic rays has also been enhanced. According to Dr Patterson, the array can be regarded as a cosmic ray telescope. By measuring the difference in time between the impact of a particular air shower on the different detectors, the angle of incidence of the shower can be calculated. This allows the researchers in the department to determine whether objects in certain regions of the sky are emitting x-rays.

The most important astronomical find of the Buckland Park Array so far has been the identification of the double or binary star system Vela X-1 as one of the sources of ultra-high energy gamma rays which bombard the earth's atmosphere.

This discovery was made by Dr Roger Clay, Dr Peter Gerhardt and Dr Raymond Protheroe of the Department's Cosmic Ray Group. It followed a similar discovery made last year by a West German group. The group, located at Kiel discovered that an X-ray emitting binary star system in the northern sky called Cygnus X-3 was emitting ultra high energy gamma-rays. This was the first detection of its type.

"Lumen" University of Adelaide

**Microprocessor centre**

Queensland industry and students will benefit from establishment of a Microprocessor Development Centre at QIT, the first of its kind in Queensland.

The Microprocessor Development Centre (MDC) was set up in October, with funding assistance from MIM, the Main Roads Department, SEQEB and QEGB, and is now operational, with more equipment arriving shortly.

Lecturer in the Department of Electrical Engineering at QIT, Mr Ian Brown, said the MDC would facilitate application of computers for specific industrial purposes.

"We are not trying to take business from consultants, rather to provide a sophisticated service to them," he said.

While the MDC could provide the support for the design of hardware from scratch for specific applications,
emphasis would be placed on customising 'off the shelf' computer modules to be built into the product.

Commercially, this was cost and time effective, Mr. Brown said.

Purchase of the MDC equipment was the brainchild of Ian Brown, who recently returned from seven years in the United States, where he worked as a design engineer for computer and telephone companies.

The contrast made me feel that Australian technology in the computer area needed much greater technical support," he said.

"With this type of facility, Australian engineers should be capable of creating products to be competitive on world markets."

WAIT’s new mass spectrometer

A new solid source mass spectrometer was commissioned in June 1984 by the Hon. David Parker, MLA, Minister for Minerals and Energy in Western Australia. Housed in a new laboratory in the Department of Applied Physics at WAIT, the Vacuum Generator’s VG 354 instrument is probably the most sophisticated of its type in the world. It represents a major investment by the Australian Research Grants Scheme ($70,000) and WAIT ($110,000). The research programme, which was mentioned in a recent ARGS review of the strength of Australian research, will be enhanced with this state-of-the-art instrument. Current research is involved with nuclear fission, nucleosynthesis, atomic weights, meteoritics, environmental physics and geochronology. Collaborative projects in geochronology with geologists from the University of WA and the WA Geological Survey, will continue to be an important aspect of the research programme.

The new mass spectrometer features a 16-sample thermal ionisation source, a revolutionary high resolution ion optical system and a multiple ion beam collector assembly which enable up to eight isotopes to be collected simultaneously under computer control.

The new spectrometer will replace the original mass spectrometer in the Department, which was purchased in 1966.

War games and scientists

The major thrust in today’s arms race came from scientists, usually physicists, Professor Peter Mason said in his opening address to the new Peace Studies course at Macquarie University. Star Wars, he said, were not invented by the military.

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Conferences and Meetings

1984

Nov 26-28
ACMS-9 Conference, F.P.O. Box 1929, Canberra ACT 2600

Dec 3-6
9th Australian Conf. on Optical Fibre Technology. Wollongong.
I.J. Hall, Dept. of Science and Technology, P.O. Box K701, Haymarket N.S.W. 2000

Dec 3-7
K.R. Cook, Sec. AIP Conf. Dept. of Applied Physics, RMIT, G.P.O. Box 2476V, Melbourne 3001.

Dec 9-12
Dr. B.A. Cornell, CSIRO Divn. of Food Research, P.O. Box 52, North Ryde NSW 2113.

1985

Feb 4-8
7th NUPP Summer School (Nuclear and Particle Physics), Canberra
Dr. M.P. Frewell, Dept. of Nuclear Physics, ANU, G.P.O. Box 4, Canberra ACT 2600.

Feb 6-8
9th AIP Condensed Matter Physics Meeting. Wagga.
Dr. A. Little, CSIRO Divn. of Applied Physics, P.O. Box 218, Lindfield, N.S.W. 2070.

Feb 10
NMR Workshop at Polymer 85, Clayton.
See Polymer 85.

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

Feb 10-15
14th Australian Spectroscopy Conference. Canberra
Conference Officer, Aust. Academy of Science, G.P.O. Box 783, Canberra ACT 2601.

Feb 17-20
5th National NMR Conference. Sydney.
Dr. R.S. Norton, School of Biochemistry, University of N.S.W. P.O. Box 1, Kensington 2033.

May 6-7
World Conference on Thermal Analysis. Salzburg.
Dr. V.M. Bhatnagar, Alena Enterprises of Canada, P.O. Box 1779, Cornwall, Ont K6H5V7, Canada.

May 13-15
3rd Australasian Conf. on Heat and Mass Transfer, Melbourne.
Conference Secretary, Dept. of Chemical Engineering, University of Melbourne, Parkville 3052.

May 13-17
Secretary, AIM Metals Congress, National Science Centre, 191 Royal Parade, Parkville 3052.

May 12-14
Dr. M.R. Taylor, School of Physical Sciences, Flinders University, Bedford Park S.A. 5042.

May 14-16
Crystal XV. Glenelg.
Dr. M.R. Taylor, School of Physical Sciences, Flinders University, Bedford Park S.A. 5042.

May 15-17
ASSIA 85 (Stereology and Image Analysis) Lindfield, N.S.W.
Dr. N. Wreford, Department of Anatomy, Monash University, Clayton Vic 3168.

June 18-19
Int. Symp. on Thermal Analysis and Analytical/Applied Pyrolysis, Quebec.
Dr. V.M. Bhatnagar, Alena Enterprises of Canada, P.O. Box 1779, Cornwall, Ont K6H5V7, Canada.

July 7-12
7th International Conference on Ion Beam Analysis, Berlin.
IBA '85, Cl. HMI, Postfach 39 01 28, D-1000 Berlin 39, FR Germany.

July 9-11
Chief Exec. Officer, A.I.M.M., P.O. Box 310, Carlton South, Vic 3053.

July 14-19
Dr. G. Kosor, Ultrasound Institute, 5 Hickson Rd, Milson's Point, N.S.W. 2061.

July 16-17
Pressure Vessel Technology Conference — Sydney.

July 17-19
Manager, PVT Conference, The Institution of Engineers, 11 National Circuit, Barton Act 2600.

July 20
4th International Congress on the Ultrasonic Examination of the Breast, Sydney.
Secretariat, IBC, Uni Dept. of Surgery, Royal North Shore Hospital, St Leonards, N.S.W. 2065.

Aug 19-21
Tenth Annual Conference of the Australian Radiation Protection Society, Melbourne.
Hon Sec, ARP, Science Centre, 35 Clarence St, Sydney. NSW. 2000.

Aug 20-23
Dr. B.B. Sharp, Civil Engineering Dept. University of Melbourne, Parkville Vic 3052.

1986

Jan 28-31
Australian Conference of Atomic and Molecular Physics and Quantum Chemistry. Hobart.
Prof. F.P. Larkins, Dept. of Chemistry, University of Tasmania, G.P.O. Box 252C, Hobart 7001.

1987

Aug 12-20
14th General Assembly and Int. Congress of Crystallography. Perth.
E.N. Maslen, Crystallography Centre, University of Western Australia, Nedlands 6009.
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