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FRONT COVER
Australia's new F/A-18 aircraft reoccing over the JINDALEE
receiving array near Alice Springs. The photo was taken by Dr
Bren Colegrove. The fact that coincidently the editors of
Engineers Australia and the Salisbury DSTO News also
published a picture of the JINDALEE receiving range last
month indicates that their radar waves could be influencing
the brain functions of the various editors.

ERRATA Vol 24, No 3
Page 55 (Letter) "On December 1986" (Error in manuscript)
Page 73 New Photomultipliers

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President's column

The past few weeks have been some of the most exciting of
my thirty three years as a physicist. The high temperature
superconductor has arrived!

No! It was not discovered here. The present flurry of activity
began with the publication in Zeits. f. Physik in September
1986 of a paper by Bednorz and Müller (IBM, Zürich)
reporting a possible superconducting state at about 30K in the
Ba-La-Cu-O system. Not only was this a jump of about 7K
in the highest known critical temperature, but the material
was a ceramic!

A short pause followed in the literature before the avalanche
broke. Confirmatory reports came in January 1987 from
Japan, AT&T Bell, Houston, Beijing,... Critical
temperatures rose steadily to near 70K, the list of
superconducting materials grew, patterns of compositional and
structural behaviour began to emerge: the compounds are
non-stoichiometric; planes of copper and oxygen atoms appear
to be the vehicle for the superconductivity; rare earths and
alkaline earths appear to be necessary - why, why, why?

Manuel Cardona talked in Sydney in early February en route
to the Condensed Matter Meeting on Pakataa Is, and reported
from his 24-hour old Phys. Rev. Letters that measurements
under pressure increased Tc; therefore, replacement of Ba in the
lattice by the smaller Sr should increase Tc. It did.

Local interest grew in February and March and was
strengthened by the return to Australia of physicists who had
attended the extraordinary evening session at the March
Meeting of the American Physical Society, when over 600
physicists in a New York Hotel discussed the phenomenon
from 7pm to 4am the following morning.

What began as a small in-house "educational" colloquium on
the new superconductors at the National Measurement
Laboratory, Sydney, late in March turned into an Australia-
wide gathering as physicists, chemists, ceramicists and
metallurgists travelled from interstate to exchange information
and swell the excitement. Then, within a few days samples
were made that showed Tc around 90K and perhaps 130K at
the National Measurement Laboratory, the University of New
South Wales, the Australian National University ...

"Yes", you reply, "another nine-day wonder - one more
overseas bandwagon rolls on to the local scene several months late". Maybe so, but I think that we are in fact seeing one of
the most significant break-throughs in physics in the past 50
years, if not the century.

The scientific and commercial rewards are enormous when
the twin advantages of superconductors - lossless current flow
and the concomitant ability to sustain a continuous magnetic
field - are fully exploited. Devices and techniques, hitherto
only available to those with expensive liquid helium facilities,
are now attainable above liquid nitrogen temperature and
even near room temperature, if anecdotal evidence is to be
believed.

History shows us that, once the breakthrough is made, the
ingenuity and effort of countless physicists around the world
will very rapidly lead to "better" material, to flexible and
malleable samples capable of being fashioned into devices and
instruments, to methods for bulk fabrication, to controllable
proportions of the superconducting phase in these so far
polyphase materials.

I write this in a certain euphoria generated by the sight of
teams of physicists, cryogenic engineers, chemists,
metallurgists and crystallographers banding spontaneously
together for a crash program on the new superconductors. We
don't know much about the structure (tetragonal, pentagonal,
nickel fluoride type?); we don't know whether the
superconducting elements are filamentary, bulk phases,
intergranular; we don't know whether the phenomenon can be
Editorial

In the last issue, April, we completed the change-over to
desk-top publishing. We were able to print the master proofs
on the Linotronic 300 printer acquired at great expense by the
W.A. Regional Computing Centre, University of W.A. and
made available by them to users for a service fee. The print is
vastly superior, because the Linotronic 300 prints 1270 lines
per inch versus 300 lines per inch from a laser printer. It
means that desk-top publishing can now produce print of the
same quality as typeset and will offer a very acceptable
alternative to scientific publishing. While it saves some
money, its great advantage lies in the fact that scientists have
far greater control over the final proofs and by producing only
one typed manuscript, errors should be easier to eliminate.
ANZAAS is organising a very timely National Forum on
Publishing in the Natural and Social Sciences in Canberra
this month, which I will be attending. I am looking forward
to meeting other editors.

As you are aware, we have been able to enjoy a colour cover
for the past three months by courtesy of Toshiba, who have
been supporting us with a full colour advertisement. It is
therefore with regret that I must report that support from the
giants of Australian industry, especially Telecom and BHP is
seriously lacking. So is support from overseas companies
like the oil companies and medical physics equipment
manufacturers, who sell millions of dollars worth of goods in
this country. Most of them do not even extend the courtesy of
answering our letters. This attitude is even more
reprehensible than the huge profits, that they announce every
year, are often based on advances in science made by
physicists. Telecom has just sent their customers a statement
that last year's operating profit amounted to $465M. The
cost of becoming a Company Subscriber to the A.I.P. is
$160 and this cannot present a financial burden to these
companies especially as it is tax deductible! The cost of
advertising in this journal, which reaches most physicists in
Australia, is also very moderate. The situation is therefore
deplorable and unfortunately demonstrates the companies' total
lack of true support to basic science and scientists, while
occasionally paying lip-service when it suits them. Some of
the comments in "Policy and Politics" in this issue of TAP
seem very relevant to this discussion.

Some of the smaller firms, however, like Quentron and
ETP-Oxford, are always supporting us and we must thank
them. I must urge all members and readers of this magazine
to make a great effort to go out and get industrial support for
the Institute and for The Australian Physicist.

In this issue we are publishing the last of the submissions
related to last year's A.I.P. National Congress. I think that it
is safe to assume that no further contributions will arrive. I
would, therefore, like to invite readers to send in
contributions, especially those who hold strong views on the
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The Future of Australian OTHR
M. Golley, Electronics Research Laboratory, Department of Defence.

On 14 October 1986, Defence Minister Kim Beazley announced a program for Australian Over-the-Horizon Radar (OTHR).

The experimental Jindalee OTHR at Alice Springs will be upgraded to provide a test bed for scientific, engineering and operational development at an estimated cost of $5.3M.

In parallel with the upgrade, a number of operational OTHRs will be designed and developed to provide broad area surveillance of our Northern approaches. While the sites have not been identified, current planning is for one or two radars in the North-East, and one in the West or South-West. The total cost of the project is expected to be about $500M.

OTHRs operate by reflecting radio waves from the ionosphere, enabling surveillance of areas well beyond the normal radar horizon. Targets are illuminated from above, making it impossible for low-flying aircraft to escape detection. Operating frequencies are in the HF band (3-30 MHz), dictated by the requirement to obtain ionospheric reflection. With frequencies very much below those used by conventional microwave radars, large antenna systems are needed to provide an adequate azimuthal resolution (the Jindalee receiving array, for example, is almost 3 km long).

By varying the operating frequency, it is possible to move the range from which the peak backscatter signal is received. Once a minimum range of operation has been selected (typically from 1000 to 3000 km) a frequency management system is required to select the optimum frequency.

A single OTHR can provide detection of air and ship targets over an area of several million square km, far in excess of any microwave radar coverage. Because of a reliance on the ionosphere, the accuracy of an OTHR can never approach that of a microwave radar. Whether the OTHR accuracy is adequate for its defence role, or whether additional support is required, is a subject for lively debate.

The Jindalee radar, in a limited form, was installed in Alice Springs in 1976 by scientists and engineers from the Electronics Research Laboratory, part of the Australian Defence Science and Technology Organisation. Several years later, an improved version was commissioned, with assistance from Australian Industry. This close co-operation between ERL and Industry will be essential for the success of the future program, with ERL concentrating on research aspects, Industry on manufacturing, and a joint effort on development work.

The future program presents many engineering challenges, for example high-power transmitters, large antenna arrays covering a wide frequency range, low-noise receivers with high linearity, high-speed signal processors and the generation of spectrally pure signals.

It also offers much for the physicist, particularly in the ionospheric field. There are ever changing propagation conditions, with variations ranging in time scales from the 11-year sunspot cycle through seasonal and diurnal to short term. To best exploit these conditions, it is necessary to understand the ionospheric phenomena giving rise to them. The following areas are of interest:

- **Shortwave fadeouts** - OTHRs cannot operate during severe fadeouts. These occur when bursts of solar radiation cause increased ionization in the ionospheric D region, which results in a large increase in absorption.
- **Ionospheric sounding** - The radar makes use of backscatter and oblique sounding in its real-time frequency management. In addition, data gathering is undertaken 24 hours/day, providing a unique data base for the Australian region. This data base enables the propagation mode structure to be studied over a wide area.
- **Multimode** - It is often possible for the radar signals to reach a target by more than one propagation mode, eg via an F layer and a Sporadic E layer reflection. This gives rise to returns from a single target at three separate delays (the extra return corresponds to different modes for the forward and return paths). It is necessary to differentiate between multimode and single mode returns from multiple targets.
- **Meteors** - Most previous meteor studies have been made towards the high frequency end of the HF band using line-of-sight observations. The Jindalee radar detects the transient ionized trails of meteors by several modes, including returns via the F-region of the ionosphere, over a wide frequency range. An understanding of meteor effects is needed to explain radar observations, and this has led to several new results in meteor physics. For example, surprisingly high meteor echo rates are observed using radar frequencies towards the low frequency end of the HF band. This suggests the existence of many more meteor trails than previously believed at altitudes above 100 km and implies that estimates of the meteoroid mass influx into the Earth's atmosphere may have been a factor of 4 too small.
- **Ionospheric irregularities** - Jindalee has higher sensitivity than most backscatter radars, enabling weak echoes from ionospheric irregularities to be detected. These are especially significant when moving, as they tend to mask target returns.

A great deal of work has been done in the past on vertical reflections from irregularities. Jindalee provides data over a wide area following oblique reflection, allowing the large scale distribution of irregularities to be mapped although no height information is available.

- **Remote Sensing** - When radio waves are backscattered from the ocean surface, a high resolution doppler spectrum of the returns shows two peaks, corresponding to reflections from water waves having wavelengths one half of the radio wavelength (modified slightly to take elevation angle into account) and travelling directly towards or away from the radar. From the ratio of these peaks, denoted Bragg lines, because of the similarity to Bragg scatter, it is possible to estimate the surface wind direction over the entire ocean area within the radar coverage area.

This information is supplied routinely to the Bureau of Meteorology. The provision of other meteorological parameters may be possible under reliably good ionospheric conditions.

- **Ground wave propagation** - The Jindalee transmitter and receiver sites are synchronised by making use of the constant propagation time of the ground wave between them.

The attenuation of the groundwave depends on the ground conductivity and permittivity, the operating frequency, the intersite separation and the irregularity of the terrain. By making measurements at different spacings and over varying terrains, it is possible to separate the effects of the different variables. For example, measurements of average ground electrical characteristics have been made over an area of hundreds of square km and to a depth of about 5 m below the surface.

Some progress has been made in all the above areas, but with the expanded program there will be a need for much additional research over the next decade. The provision of multiple sites will present new challenges.
Solar, Terrestrial, Cosmic Ray and Space Physics: Highlights of Workshops at The 7th National Congress
B.J. Fraser, Department of Physics, University of Newcastle.

The AIP Seventh National Congress was held at the University of Adelaide from August 25-29, 1986. A series of topical workshops were organised by the Solar Terrestrial and Space Physics (STSP) Group within the AIP under the chairmanship of Professor K.D. Cole. The aims of the workshops were to bring together the Australian community on STSP and a few overseas visitors in an informal environment, and to provide a forum where current research could be presented and discussed. This followed the successful series of workshops held at the Sixth Congress at Griffith University in 1984.

The workshop topics included cosmic ray physics (Convenor R.W. Clay), solar and stellar activity (C.J. Durrant), solar terrestrial environmental forecasting (D.G. Co) and the associated developments (P.L. Dyson, high latitude and upper atmospheric physics (P. Jacka), geomagnetic variations, pulsations and VLF emissions (F.W. Menk) and the middle atmosphere program (W.G. Ellord).

There were approximately ninety participants with direct interests in STSP and all workshops were well attended. A total of ninety-five papers were presented over five days, an increase of about fifteen over the previous congress. With this increased commitment, and with eight invited oral presentations, it was impossible to avoid parallel sessions. However, these were arranged between topics with minimal expected overlap in audience interest.

The summaries presented below have been contributed by the particular workshop convenors. It is not possible to review the presented papers in detail and the summaries are intended to convey a balanced view of the highlights of the topics covered. Papers of which all but eight were oral presentations, it was impossible to avoid parallel sessions. However, these were arranged between topics with minimal expected overlap in audience interest.

The summaries presented below have been contributed by the particular workshop convenors. It is not possible to review the presented papers in detail and the summaries are intended to convey a balanced view of the highlights of the topics covered. Papers of which all but eight were oral presentations, it was impossible to avoid parallel sessions. However, these were arranged between topics with minimal expected overlap in audience interest.

The STSP programme also included three plenary review lectures presented to all physicists at the open congress sessions. The first review, by C.J. Durrant, discussed our present understanding of the physics of the Sun. Recent developments in this area have forced a re-evaluation of the standard stellar model. New results from solar neutrino experiments and global oscillation observations are not explainable by previously accepted solar dynamo models have provided the impetus for a more extensive network of ground-based observatories and a detailed consideration of the role of magnetic field evolution in models of solar dynamos.

However, resulting predictions of likely solar cycle behaviour do not find support in terrestrial rock deposit observations.

R.L. Dowden presented a review outlining the significance of ground-based observations of VLF emissions. Since the first reported space station study of VLF emissions in 1894, (as reported by Preece, Nature 49, 544) observational evidence and theoretical developments (first theory can now explain characteristic features of these signals, including field-aligned multipath propagation, electron-cyclotron wave amplification, field-aligned reflection and dispersion to hiss). Recent developments include experiments on VLF wave stimulation and an understanding of the amplification process leading to hiss emissions.

R.A. Vincent presented a survey of the basic structure of the Earth's middle atmosphere, emphasizing the importance of various energy input mechanisms such as solar UV and IR radiation, N2O, CH4, planetary and gravity waves and tides. International coordination in investigating these features during the Middle Atmosphere Programme was also outlined. Two current problems were highlighted: the role of transport processes in accounting for global middle atmosphere temperature profiles; and the significance of the recently reported 40% springtime Antarctic ozone depletion.

Important questions relating to this phenomenon in particular and our incomplete understanding of the middle atmosphere in general were indicated.

Cosmic Rays
R.W. Clay, Department of Physics, University of Adelaide.

The Cosmic Ray workshop reflected the present vigorous state of the discipline in Australia. A wide variety of work was reported, ranging from planned experiments to work which has recently been completed, broadly spread through most of the cosmic ray field. Major centres of Australia's cosmic ray community were represented, Adelaide, Hobart and Sydney, and work in most of their areas of interest was reviewed.

The University of Sydney has recently completed analysis of data from its huge SUGAR array which recorded giant cosmic ray air showers near Narrabri for over ten years. This important experiment has been the only significant southern hemisphere contribution to the study of air showers with energies over $10^{17}$eV and two notable results have been recognised. (1) There is still no convincing evidence from isotropy of the highest energy cosmic rays despite their energies being such that they travel essentially in straight lines in known galactic and intergalactic magnetic fields. (2) There is no evidence for the expected cut off of the $10^{15}$eV cosmic ray beam due to interactions with the 2.6K microwave background. Indeed, there is strong evidence for a flattening out of the energy spectrum above about $10^{17}$eV. This result is particularly perplexing when combined with result (1) since it seems to demand a local cosmic ray source, a conclusion which is apparently precluded by favoured interpretations of the anisotropy.

On a more local front, solid progress in planning and new construction has been made by the Sydney group on an underground water-Cerenkov experiment to search for solar neutrinos. A number of approaches to this problem are being made worldwide. The Australian experiment in the North Broken Hill mine will have directional resolution through the Cerenkov effect to track the Sun and it will have a low neutrino energy threshold to give it a particularly useful place in the international hierarchy.

The University of Hobart and the Antarctic division have a worldwide reputation for studies of the modulation of cosmic rays in the heliosphere. This is at the completely opposite end of the cosmic ray energy spectrum from the SUGAR studies and this cosmic ray beam is used as a probe of, particularly, the heliospheric magnetic field. Issues of interest are the density of cosmic ray particles in our local region, and its gradient, together with the variable magnetic field structure in the heliosphere. It was interesting for me to realise that the Forbush decrease phenomenon is not so nearly well understood as I had imagined and that there is still a great need to continue long-term monitoring of the cosmic ray background with neutron monitors. It seems that the more we learn about the solar cycle, the more there is to understand and we need high quality records over a number of cycles before we can finally expect to feel that heliospheric studies are in good shape.

Cosmic ray studies have a tradition of requiring high altitude observations and a section of the cosmic ray community has always required high altitude balloons and spacecraft. Australia has had long experience in such areas and X-ray astronomers here have been to part of the vital development of space expertise in Australian industry. An imaginative Hobart/ADF (Australian Defence Forces
Academy) proposal for the Mirraboeka project is a strong contender as a scientific payload whilst local industry prepares to become "space qualified" prior to the production of local space technology.

In Adelaide, we have been working hard on developing our programmes in ultra high energy gamma ray astronomy (at $10^{13}$eV) and its very high energy ($10^{12}$eV) cousin. Air showers from the directions of possible astronomical sources are examined to find characteristic time signatures (typically in neutron star binary systems with characteristic orbital or pulsar periods).

In the UHE range we use a high angular resolution development of our well established air shower array at Buckland Park and have already had a recently confirmed observation of Vela X-1. In the VHE range we are building a telescope to detect the atmospheric Cerenkov light from these low energy showers. A total light collecting area of some 90m$^2$ is proposed and we will use a number of techniques to optimise our signal to background ratio. In the meantime, we have been obtaining useful data and valuable experience with nighttime use of the light collectors at the White Cliffs Solar Power Station. A group from England is also about to begin VHE work in Australia, at the old SUGAR site, and we are looking forward to some constructive rivalry!

A traditional area of cosmic ray research has been concerned with the properties of shower cascades. The Sydney group is nearing completion of a system to study the cores of these cascades, an important and controversial area of interest, still at energies above those of present day colliders. Also in Adelaide we have been able to use our data to throw light on proton-air interactions at the highest energies.

**Solar and Stellar Activity**

C.J. Durrant, Department of Applied Mathematics, University of Sydney.

This workshop addressed several problems of solar activity, which is assumed to be a model for activity process in other stars. In the words of Prof. K.D. Cole, this is 'local astrophysics' - astrophysics where we can observe the processes in some detail and subject theory to verification.

Several speakers dwelt on the inadequacies of our knowledge of the basic mechanisms of activity revealed by the proximity of the Sun. Even the most ambitious numerical simulations of the solar cycle fail to reproduce many important aspects of the observations; hence their physical basis is questionable. Under these circumstances, simplified mathematical models of solar processes which are valid only for situations far removed from those obtaining in the Sun must be viewed with some scepticism.

The current state of understanding of solar flares is in a similar situation. Whilst some progress has been reported in the treatment of the global aspects of coronal electrodynamics, the detailed processes by which electromagnetic energy is produced, stored and released in the solar atmosphere has not yet been identified.

The analysis and interpretation of observations thus remains a key task of solar physics. At the Adelaide workshop significant results were reported on three fronts. D.E. Rees described his work, conducted in collaboration with the High Altitude Observatory, Boulder, Colorado, on the analysis of the polarization profiles of Zeeman-split spectral lines.

Numerical modelling has shown that the vector magnetic field may be extracted from observations using only a simplified treatment of the thermodynamic state of the atmosphere. This is possible only if account is taken of the magneto-optical effects previously ignored. The ability to now map the magnetic field at the solar surface should yield new insight into the structure and evolution of the fields which are the basic component of the activity cycle.

The second highlight was the observation of 5-min oscillations in a narrow band around 410 MHz which were initiated by an impulsive flare. C.S. Wright and G.J. Nelson interpret these oscillations as a standing wave in a coronal magnetic flux loop spanning half the solar diameter. Loops connecting distant active regions are known from X-ray and EUV observations, but the radio pulsations provide the most convincing evidence to date of dynamical effects and open up a new field of loop diagnostic techniques.

The third Australian contribution to progress was provided by J.G. Winten who described the imaging triple Fabry-Perot filter developed by CSIRO Division of Applied Physics. This filter has a passband of 2 to 5 pm, narrow enough for solar spectroscopy, and has servo systems which maintain the parallelism and spacing of the interferometer plates to an accuracy of 3,400 even when the instrument is subject to severe mechanical disturbances. The very first photograph of the Sun obtained with the filter mounted on a telescope in the open air demonstrated that the instrument indeed met its design goals.

In summary, the workshop provided ample evidence that much remains to be done in understanding the ultimate sources of solar terrestrial and space physics, but also that solar physicists in Australia are aware of their importance and are actively engaged in research programs on both the national and international fronts.

**Solar-Terrestrial Environment Forecasting**


This workshop concentrated on the forecasting of ionospheric characteristics from the lower level of sporadic E through to the F2 level and included overall characteristics such as ionospheric indices and real height profiles. Practical aspects of predictions for communications purposes were provided within the context of optimum working frequency calculations, the interpretation of oblique ionograms and the accuracy of radio noise forecasting.

The most important theory of sporadic E formation, the windshear theory, while explaining some gross sporadic E features, is still not capable of specifying all observed characteristics.

Although sporadic E layer occurrence is higher where the horizontal magnetic field is greatest, this alone does not give a complete geographic description of sporadic E occurrence. Nor can the magnitude of the summer maximum in occurrence be reconciled with the equinoctial occurrences and there is no satisfactory explanation for the winter submaxima.

Sporadic E appears as cloud-like structures but again there is no satisfactority theory as to why this should be so. J.D. Whitehead (University of Queensland) suggested that this may eventuate through the break-up of thin layers. A call was made for greater consistency in the handling of statistical data for the occurrence of sporadic E so that such variations in occurrence rates as appear between Japan and Queensland can be confirmed as real.

The use of backscatter sounder data to predict HF communication depends heavily on interpretation. Although backscatter ionograms may be considered as a superposition of many oblique ionograms, non-uniformity in the ionosphere means that backscatter ionograms seldom look like the simple models. By comparing basic ionospheric data, from the Alice Springs backscatter sounder out to 3000 km, with predicted data, K.J. Lynn (Defence Research Centre) has been able to confirm major distortions in the median ionosphere and detect trends.

The reliability of predicted ionospheric parameters of the type used by Lynn depends on the accuracy of the data archived and their interpolation to geographic areas where no data have been monitored.
The Australian maps of ionospheric F2 data have recently been updated to incorporate foF2 median data accumulated since 1972. The fitting of data to the regions where no monitoring stations was done using its model data in mid latitudes and IPS data in high and low. A grid of data points has been produced, checked and found to be of good quality through the Australasian area. The maps have also been checked by M.W. Fox (IPS) against control data and against data collected by the Japanese ISS-s satellite. It is anticipated that the IPS data maps will be prepared as numerical coefficients and presented as an international standard at the next IUSI meeting.

Statistical separation of the foF2 data into upper and lower deciles will provide an improved data base for calculating Optimum Working Frequencies (OWF) for communications. Fox has tested decile factors taken from actual Australian data and compared them against CCIR factors that were derived from a restricted sample of data.

Selecting correct data from an archived dataset of a prediction system requires a predicted index of the gross features of the ionosphere. P.J. Wilkinson (IPS) has calculated a daily index that estimates the solar effects on the ionosphere, and a disturbance index which acts as a quality figure for major variations in ionospheric parameters. By using the second index to qualify the use of the first, Dr. Wilkinson has developed an ionospheric index for daily purposes.

Lea-McNamara (Andrew Antennas) described the validation methods for controlling the quality of real height profiles obtained automatically from digital ionograms. He described five techniques by which the reliability of the profile could be verified. The techniques could be used to reject unreliable profiles and thereby avoid the use of inconsistent data in modelling.

The bottom line in circuit planning is radio noise. Where this is natural noise, the standard CCIR atmospheric noise maps are used. These are based on worldwide but geographically sparse measurements and grouped by four-hour time blocks and four seasons. The present set of maps is in contention over the Australian region where measurements made by Bruce Ward (DSTO) indicate values lower than those modelled by CCIR. A comprehensive series of noise measurements at Alice Springs has shown that night time noise is more impulsive than daytime and that directional antennas can reduce noise if the known source directions can be avoided.

The normal methods of predicting ionospheric characteristics use global datasets for empirical modelling. The international SUNDIAL campaign has been established to create an ionosphere-magnetosphere dataset that will be used to test and improve current prediction models. Following an initial measurement period in October, 1984, further periods in September 1986, June 1987, March and December 1988, October 1989, June 1990, March and December 1991 will be studied. This programme will cover four seasons, two levels of solar activity.

When the second generation AUSSAT satellites are launched in 1990-91 there may be space onboard for scientific packages. E.A. Essex (La Trobe) described a proposal being put forward by IPS and La Trobe and Monash Universities for a radio beacon experiment. Behaviours at VHF, UHF, SHF will provide routine monitoring of the total electron content (TEC) of the ionosphere by the Faraday rotation technique, differential group delay using the modulation and differential carrier phase of all three frequencies, as well as the normal amplitude (scintillation) measurements. Of particular note was the wide receiver coverage which includes Australia, China, Japan, N.Z. and the Pacific. Opportunities exist for studying ionospheric gradients, large and small-scale irregularities, ionospheric storms. The results could have uses for the ionospheric community, geodesy, radio astronomy, sea state radars, navigation and education.

Ionospheric Irregularities
P.L. Dyson, Department of Physics, La Trobe University.

The first group of three papers on this topic by D. Meehan and J.D. Whitehead, G.G. Bowman, and J. Scali and P.L. Dyson reported results of observations on F-region irregularities known as Spread F. The University of Queensland operates two HF radar systems and La Trobe University operates one to measure time delay, angle of arrival, Doppler shift, amplitude and dispersion of ionospheric echoes. These two systems therefore have many similarities but they differ in their resolution and flexibility. There is general agreement in the observations that spread F is primarily due to specular reflections from moving structures in the ionosphere. However, a consistent picture of the small-scale structure has not yet emerged. The detailed measurements of Bowman show that even in daytime when spread F is not normally observed on routine ionograms, weak range spreading can be detected from small-scale irregularities.

The group of papers presented by scientists from the Defence Science and Technology Organisation (DSTO) included papers giving preliminary results of observations made by the JINDALDEE Skywave Radar System (R.M. Thomas and M.L. Lees) and associated frequency management facilities (G.F. Earl and B.D. Ward). These systems obviously can be valuable tools for studying ionospheric irregularities and they are most effective when combined with sophisticated data analysis procedures. This was well illustrated by the new technique described by Earl and Ward for obtaining group delay and Doppler characteristics.

Papers by J.D. Whitehead, J.A. Bennett, P.L. Dyson and C.A. Johnson, I.G. Platt and P.L. Dyson, and J.D. Whitehead and J.H. MacGibbon discussed different aspects of calculating ray paths in ionospheric models. Bennett et al. used the CYBER 205 supercomputer to trace rays in ionospheric models containing wave irregularities. The approach is effective in giving a global picture of the effects of irregularities on radio wave parameters. It readily shows rapid changes which might be overlooked with other approaches.

High Latitude Ionospheric and Upper Atmospheric Physics
F. Jacka, Mawson Institute, University of Adelaide.

These sessions were held over two afternoons during which 12 papers were presented; attendance ranged from about 10 on the first day to 30 on the second day.

The major experimental work was presented in a series of six papers on the dynamics of the upper atmosphere from the Mawson Institute for Antarctic Research, University of Adelaide. (The authors were P. Wardill, N. Jones, A. Phillips, G. Price and F. Jacka.) These papers were based on observations at Mawson, Antarctica, with a scanning Fabry-Perot spectrometer to measure doppler shift and broadening of auroral optical emission lines from the 250 km and 120 km regions and an HF radar to measure drift of ionization in the 70 to 100 km region.

At 250 km in the thermosphere the main features of the data fit well with global models assuming that the high latitude circulation is driven primarily by momentum transfer fromconverting ions following ExB. The electric field is generated by interaction between the solar wind and the geomagnetic field and is mapped onto the ionosphere via the nearly equipotential geomagnetic field lines. Changes in this electric field are manifested in changes in geomagnetic activity and in the thermosphere wind; changes are seen in the pattern of thermospheric wind result from changes in the azimuthal component of the interplanetary magnetic field. These effects are well illustrated by the Mawson data.
At 120 km, the where the ion-neutral collision frequency is more nearly comparable with the ion gyro frequency, the wind direction lies between that of ExB and E. At heights down to about 80 km the amplitude of the diurnal variation in the wind increases strongly with geomagnetic activity; this increase is tentatively attributed to ion drag in the direction of the electric field. At all levels there is evidence of quasi-periodic variations of wind with periods of tens of minutes which are attributed to gravity wave action. At 250 km it is necessary to invoke gravity wave momentum transfer to explain the observed divergence of the wind field.

Three other papers on experimental work were presented. The measurement of temperature in the mesosphere based on OH rotational spectra from Davis, Antarctica, was discussed by P.F.B. Williams (Antarctic Division, Department of Science).

Data on total ionospheric electron content at Macquarie Island, based on measurement of Faraday rotation of satellite beacon signals, were reported by R.A. Eaves (La Trobe University); increases of up to 150% were associated with auroral activity.

L.A. Hajj and R.D. Hunsucker (Queensland University and University of Alaska) presented mid-latitude data which demonstrate equatorward propagation of travelling ionospheric disturbances originating simultaneously in the auroral zones of both hemispheres.

From La Trobe University, D.Y. Zhan and K.D. Cole presented theoretical investigations on the initiation, maintenance and decay of thermospheric motions caused by electric fields and the effects, involving Joule heating and local rotation, in the thermosphere of geomagnetic field-aligned currents. Another paper, by B. Romanin and K.D. Cole, gave an excellent review of magnetic merging. The theory was outlined first for weak Newtonian fields as applicable to the earth's magnetosphere and then for strong gravitational fields as may be applicable to pulsar magnetotail reconnection, interaction of binary pulsar magnetospheres and accretion on black holes.

Geomagnetic Variations, Pulslations and VLF
F.W. Menk, Department of Physics, University of Newcastle.

The workshop on geomagnetic variations, pulsations and VLF commenced with a tutorial lecture by R.L. Dowden discussing the interrelationships between varying geomagnetic phenomena. These include balloon-measured X-ray fluxes which correlate with VLF chorus emissions on the ground, auroral luminosity pulsations and synchronously modulated magnetic variations in the ULF range, and correlated CNA and QP VLF fluctuations. Various interaction models were presented and possible cause-to-effect pathways outlined.

Some 12 contributed and 8 poster papers, plus a rapporteur poster review, representing about 9 decades in geomagnetic variation frequencies, were presented in this workshop. The scope of the subject was emphasized by the first paper, presented by D.V. Thiel, which described the theoretical and practical implementation of resolving surface impedances at VLF in geoelectromagnetic phenomena. Other manifestations of ground induction effects on natural geomagnetic signals were described by P.R. Milligan, who presented results of a survey outlining the relative importance of the coast effect at BMR standard magnetic observatories. I. Ferguson, who evaluated the effect of the Tasman Sea in analysing geomagnetic signals recorded across an underwater array, and R.L. Kellett, who presented induction vector results from an associated study in New Zealand. N. Bindoff applied a Taylor series transfer function to seafloor electromagnetic data to discriminate the magnetic and electric tide induced components from the harmonics of the ionospheric component. A poster presentation by R.J. Sennett and D.E. Winch demonstrated the contribution of the seasonally corrected lunar tide to geomagnetic signals at auroral and equatorial latitudes. In a further paper they explained variations in quiet nighttime magnetic data from expected values in terms of the influence of partial ring currents. E.C. Butterick found that on geomagnetic abnormal quiet days there is an IMF-dependent reduction in the currents associated with, and whose variation modulates the amplitude of, the Sq(H) system.

The Saito et al. presented two new models of substorm formation, based upon analogies to observations of quasi-polar solar wind interaction with Comet Halley ion tail disturbances. A poster presentation by T. Saito et al. also demonstrated the possible influence of evolution of the heliomagnetosphere over a solar cycle on Pc3 pulsations at Earth. K. Yumoto et al. outlined a theory by which solar wind energy may be transmitted through the magnetosphere, thus accounting for some properties of low latitude Pc3 pulsations being studied with an extensive ground station array described by C.W.S. Ziesolleck et al. J.P. Morriss and K.D. Cole investigated properties of Pc3 at high latitudes, many features of which had not been described previously. A.W.V. Peacock and P.R. Sutcliffe showed that the propagation of Pc3-4 pulsations through the ionosphere is associated with fluctuations in ionospheric electron density, while F.W. Menk and J. Vero demonstrated that Pc3 signals may be significantly attenuated at times of high F-region electron densities. D.J. Webster et al. reported results of a search for some conjugate response to a high latitude RF ionospheric heating experiment modulated at Pc1 frequencies. The lack of qualitative results may have been attributable in part to the low probability of obtaining optimum conditions for magnetospheric propagation of the ULF signals. B.J. Fraser et al. related the spatial and temporal characteristics of ULF ion cyclotron waves to plasma density distributions observed near the plasmapause. A further poster paper by B.J. Fraser et al. used satellite and ground data to trace such a wave event in its propagation from the magnetosphere to the ionosphere. M. Craven and G.B. Burns showed that correlated pulsations in auroral luminosity and P1 activity may be signatures of fluctuations in the height-integrated D- and E-region conductivity modulating Hall and Pedersen currents, resulting in associated magnetic variations on the ground.

The Middle Atmosphere Programme
W.G. Elford, Department of Physics, University of Adelaide.

The four-year Middle Atmosphere Programme that concluded at the end of 1985 has resulted in a great improvement in our knowledge of the region between 10 and 100 km, particularly through the exploitation of remote sensing techniques using satellites and ground-based radar. In view of the success of MAP it is continuing at MAC (Middle Atmosphere Co-operation) until the end of 1988.

A major technical innovation during the Middle Atmosphere Programme has been the commissioning of a number of VHF radars for determining height profiles of horizontal and vertical winds with unprecedented resolution in time. In a Workshop sessions R.A. Vincent gave examples of tropospheric wind profiles measured with new Adelaide VHF radar. Excellent agreement is obtained with winds determined from radiosonde observations. A specific study of the horizontal and vertical winds measured during the passage of a cold front indicates that the system has great potential in meteorological studies of such phenomena.

The Atmospheric Physics Group at Adelaide has shown that large low frequency radio arrays can be used to study mesospheric turbulence and momentum flux; in particular the
array at Buckland Park, South Australia has been used to make these measurements. W.K. Hocking of Adelaide presented the main features of a year's measurements at 2-hourly intervals of the dissipation rates of turbulent energy in the mesosphere, and D. Murphy described measurements of momentum flux obtained during periods around the winter and summer solstices.

High latitude mesospheric wind data are now being obtained on a continuous basis at Mawson, Antarctica. A. Phillips of the Mawson Institute of Antarctic Research, Adelaide, presented the results of a year's observations of winds between 70 and 110 km at Mawson. The mean circulation and the tidal winds show some similarities with data from similar latitudes in the Northern Hemisphere, but also some distinctive differences which are likely to be of value to theoretical modellers.

Until recently the measurements of upper atmosphere winds have failed to reveal the presence of a component due to the atmospheric lunar tide. R.J. Stening of the University of New South Wales reported the first detection of lunar tidal winds at 82-100 km in five years of continuous wind data obtained at Saskatoon, Canada. The tide has a vertical wavelength of more than 100 km in summer and about 26 km in winter.

Optical studies of the middle atmosphere are being carried out by members of the Mawson Institute for Antarctic Research. P. Greet reported on preliminary observations of the sodium layer at 90 km using a Fabry-Perot spectrometer, and S. Argall and F. Jacka described a new lidar system based on a copper-vapour laser that will be used to study the structure and dynamics of the atmosphere in the height range 5 to 70 km.

Further developments of a general circulation model for the middle atmosphere were described by B.G. Hunt of the Division of Atmospheric Research. The dissipation due to the breaking of internal gravity waves can be adjusted to produce a circumpolar vortex whose strength is similar to that observed, and the recent inclusion of solar diurnal variability generates realistic tidal winds above 70 km. The model now has the potential to study the effects of perturbations in solar U.V. and Joule heating at the upper levels.

T. Van Zandt of N.O.A.A., Boulder, U.S.A. pointed out that observations of velocity fluctuations in the middle atmosphere at large vertical wave-numbers indicates that the gravity wave field at these wave-numbers is saturated. Also, where the buoyancy frequency increases rapidly the dissipation of gravity waves is enhanced, a feature which gives rise to enhanced reflectivity of VHF radar signals from the mesopause region in the Arctic summer.

The one paper not dealing with the dynamics of the middle atmosphere was concerned with low frequency radar observations of meteors using the Buckland Park array. D.I. Olsson-Steel and W.G. Ellford showed that the true height distribution of radio meteors is significantly greater than commonly believed, having an upper limit of about 140 km and a peak near 105 km. As a consequence the meteoric input to the atmosphere has been hitherto underestimated by at least an order of magnitude.

**Wagga Goes to Pakatana**

*Paul Callaghan, Massey University.*

The island of Pakatana in Auckland's Hauraki Gulf was the scene of this year's Condensed Matter Physics Meeting, traditionally held at Wagga-Wagga. Every four years the Australian and New Zealand Institutes of Physics shift the venue of the CMP meeting to New Zealand, partly to encourage the participation of New Zealand research students and partly to take advantage of the delights of Pakatana. Organised by Glynn Jones and his team from Canterbury University, the 1987 meeting drew 96 participants with 39 New Zealanders, 49 Australians and 8 from other countries. 28 research students attended with assistance from the AIP and NZIP. In accordance with custom the registration fee was kept to a minimum with no financial assistance being offered to invited speakers a fact which in no way discouraged the attendance of several distinguished participants.

"So I said to my wife-No honestly, we're going there to work."

The meeting, held from the 4th to the 6th of February, followed a formula of invited lectures, a smaller number of short contributed talks and two major poster sessions. The content covered structure, dynamics, ordering, elementary excitations and critical phenomena in metals, semiconductors, rare earth halides, antiferromagnets, surfaces and low dimensional systems, polymers and liquid crystals. The emphasis at this year's meeting was experimental including techniques as diverse as low temperature nuclear orientation, Raman and Mössbauer spectroscopy, NMR, NQR, EPR, ellipsometry, electron tunnelling, neutron and X-ray diffraction and measurements of conductivity and susceptibility.

"Right, that's settled. We'll have the swim after lunch but before the siesta."

The standard of presentation was high with the conference being treated to some vintage lectures. Highlights for this reported included a review of the beautiful physics of low temperatures by Graham Bowden, a lucid report by Eddie Seymour on his metal-hydrogen experiments and a breathless but delightful lecture on light scattering in semiconductors by Manuel Cardona. Professor Cardona, from the Max Planck Institute, provided an unintended but graphic illustration of
the difficulties associated with attempts to apply compressive strain when he leaned on the wooden pointer, splitting it neatly asunder mid-sentence.

Somehow, in the early mornings, between the physics, and in the evenings, the participants managed to fit in a hectic schedule of swimming, exploring rockpools, watching the seabirds and fishing. Notable successes included five snapper in an hour to New Zealand student Yang Xia and one Kahawai and one Kingfish (and subsequent broken line of course) to ADFA physicist Don Chaplin.

Australia attempting to take a core sample of the New Zealand boat during the ironman event.

In place of a Koakaburra-K27 final an Australia vs New Zealand “iron person” competition was held comprising twelve rowing, running and swimming legs in relay. The result was a New Zealand victory although the outcome was nearly jeopardised by Fred Smith attacking New Zealand competitors with an (underarm) oar.

Cultural and entertainment highlight of the week was the lecture on Earnest Rutherford by John Campbell. As well as discovering the true spelling of young Earn’s name, John has revealed that New Zealand’s most famous son began his research career at the then Canterbury College as a materials scientist investigating the high frequency magnetization of iron. The link with materials was further established in a later lecture by George Stirling from the Rutherford Appleton Laboratory near Oxford. George pointed out that the major facility at this institution is the spatterion neutron source, ISIS, which is devoted to more modern investigations in condensed matter physics.

Four prizes of exclusive T-shirts were awarded for communication skills.

Best Walking Bill Board for Physics
Fred Smith (Monash)

Best Lecture Presentation (chosen by 3 research students)
Eddie Seymour (Warwick)

Best Student Poster (presentation and verbal defence)
David Maddison (Macquarie)

Best Poster
Michael Kopp (ADFA)

After four days of glorious weather the CMP group took the two hour ferry journey back to Auckland accompanied by leaping dolphins amidst an armada of Waitangi day sails. For those unfortunates who missed out, your chance will come again in 1991.

DSIR and the New Zealand Universities finally decide on a method of dividing up the research budget - winner takes all.

OVERSEAS SCHOLARSHIPS
FRANCE
FRENCH GOVERNMENT SCIENTIFIC FELLOWSHIPS

The French Government is offering a limited number of Fellowships to enable Australians working in scientific fields to visit France for three to six months in the period February to December 1988 to further their experience through observation and participation.

Benefits: (a) Monthly allowance ranging from 3000 FF to 3600 FF to be determined according to the qualifications of the successful applicant.
(b) Economy class air travel from France to Australia.
(c) Registration fees.
(d) Some internal travel.

Note: Travel to France from Australia is not provided.

Conditions: Applicants must be: Australian citizens, at least 25 years of age at 1 January 1988, possess appropriate academic qualifications, have some knowledge of French and present a detailed program including advice of acceptance from a French institution.

Further information and application forms are available from:
The Secretary,
Department of Education
(French Government Scientific Fellowships),
PO Box 826,
Woden, ACT 2606.

Closing date: 12 June 1987.
BOOK REVIEWS


The first question which must be asked about this book is whether it is merely an up-date of Dr Budden's 1961 book on 'Radio waves in the ionosphere'. This latter book is of course a classic, the foundation of many a Ph.D. thesis. Whilst the new book tackles many of the same problems as the old, the approach is often different and not only takes into account advances in the subject, but the considerable changes in the way we do physics, particularly in the use of computers.

The approach is theoretical, with a refreshing emphasis on understanding the basic physics principles. Written by a physicist for radio engineers, it nevertheless suits his fellow physicists in the well, the mathematics, is never beyond that of an Honours student, the explanations clear and lucid and a knowledge of the ionosphere is not required to follow the physics.

The book deals with linear propagation of radio waves through magneto-ionic plasmas: a horizontally stratified ionosphere is used as the primary example and source of terminology. Naturally such topics as slowly changing media, ray tracing, reflection, polarization and coupling between characteristic waves are major topics.

Problems at the end of each chapter make the book suitable as an Honours text; otherwise it will be as widely used as its predecessor as a basic reference book.


This report of the U.S. National Council on Radiation Protection and Measurements is a comprehensive review of research on the biological effects of RF electromagnetic fields. It follows an earlier report (No. 67) which provides background material on the mechanisms of interaction of RF EM fields with tissue. It encompasses a discussion of the available literature on the effects of RF at all levels from the molecular and sub-cellular to behavioural studies, including sections on chromosomal and mutagenic effects; effects on reproduction, growth and development; interactions with the nervous system and thermoregulatory response in humans.

The report is timely in view of the rapidly expanding medical applications of RF, notably in diathermy and magnetic resonance imaging (MRI) and a growing concern in the community over potential hazards, stemming in part from wide publicity concerning the irradiation by the Soviets of personnel in the U.S. Embassy in Moscow in 1976. Like many of the studies covered by this report, results of follow-up investigations in this case proved inconclusive and there is clearly a need for better controlled experiments in the field.

The final chapter of the report reviews the development of exposure criteria. Overall, while not recommended for the general reader the report is a very useful work of reference for those concerned in a professional capacity with safety of RF fields.


The complexities of traditional deterministic systems, such as those described by classical Hamiltonian mechanics, have been known and appreciated for a considerable time. Probabilistic ideas for dealing with such complexity, especially for mechanical systems with many degrees of freedom, were developed last century by Maxwell, Boltzmann and others and in particular by Gibbs who provided us with well defined probability densities for computing macroscopic or average properties of such systems. This book, as the authors put it, is about densities, but in a wider context than Gibbsian statistical mechanics. In fact the Gibbs densities score only brief mention in an example given in Chapter nine.

In recent years there has been an explosion of interest in dynamical and deterministic systems which exhibit irregular or chaotic behaviour. Such systems need not be mechanical nor possess many degrees of freedom and occur in economic models as well as more traditional branches of science. The authors' contention is that a useful unifying description of chaotic-type behaviour can be given in terms of densities. Much of the book gives evidence by way of examples in support of this contention.

The authors begin in Chapter one with a nice heuristic discussion of the one-dimensional quadratic map \( x \mapsto 4x(1-x) \) which was discussed many years ago from the density point of view by Ulam and von Neumann. The histogram obtained from iterates of the map becomes the density in a question which in turn is shown to be the fixed point of the so-called Frobenius-Perron operator. The properties and uses of this operator in general form a recurring theme throughout the book.

After such a promising and appealing start some practically-minded readers may be put off immediately by the next few chapters, and in some cases by the rest of the book, which deals with rather abstract concepts from measure theory, Lebesgue integration, ergodic theory, smooth manifolds, and Markov processes. The book is in fact an unusual mixture of practical down-to-earth examples, drawn mainly from the physical and biological sciences, and rather abstract pure mathematics. Most books which attempt such a combination are failures by virtue of the fact that they do not appeal to either the applied practitioner or the more pure mathematically inclined. This book is perhaps an exception.

This reviewer would have preferred more of the style presented in the first Chapter, but clearly the authors' intention was to expose the reader to rather general and abstract results and techniques in the hope that through the many revealing remarks and examples, the book would appeal to physicists, chemists and biomathematicians studying chaotic behaviour as well as to mathematicians working in dynamical systems and ergodic theory. On the whole the authors have been reasonably successful in their attempt although it is probably fair to say that the book will appeal more to the mathematician interested in applications than to the other scientists who would like to understand more of the mathematics.

The book covers a great deal of material, including the behaviour of discrete and continuous time systems, notions of ergodicity, mixing and convergence in a general setting, Boltzmann-like equations and entropy, and stochastic perturbations. If anything the authors have tended to cover too much material in too great a depth.

The authors claim that they assume only a knowledge of advanced calculus and differential equations but in the
reviewer's opinion this assumption is highly optimistic.

This is not a book for the faint-hearted, but for those with a deep interest, or desire to learn about dynamical systems, ergodicity and chaos, its reading will be a rewarding and at times demanding experience.

Reviewed by M.R. Grimshaw, School of Mathematics, The University of New South Wales.

Although this text is one of a series of books intended for research students, it has in fact been written for a first course in solid and fluid mechanics. In Australia, it would be suitable for a third-year undergraduate course, or possibly for an advanced second-year course. In spite of a title which indicates that some exotic materials might get a mention, the text contains a traditional straight-forward account of linear elasticity and fluid mechanics for fluids of constant density. It is similar to comparable texts at this level, and would not appear to offer any substantial advantage over the better known competitors. As a consequence of treating both elasticity and fluid dynamics in the same text, neither subject is developed to any great depth. For instance torsion problems do not rate a mention, while boundary layers in flow past an obstacle are only briefly discussed. On the other hand I thought rather too much space was given to anisotropic elastic materials for a beginning text. Another strange anomaly is the inclusion of some material on scattering of elastic waves at a boundary, without any mention of Rayleigh surface waves. Tensors are introduced early, but strangely, full use is not always subsequently made of tensor notation. In spite of these criticisms this is quite a readable text, and could be useful as a first course on continuum mechanics.

Reviewed by M.R. Grimshaw, School of Mathematics, The University of New South Wales.

This short text is an outgrowth of a graduate lecture course, and is aimed primarily at post-graduate students, although all researchers in fluid mechanics, who are not specialists in turbulence, will find this introduction to turbulence and related fields quite useful. The book introduces the reader to the standard concepts in the theory of turbulence with the main emphasis on homogeneous turbulence and shear flows, the latter including both boundary layers and mixing layers. The main analytical tools used are a mixture of statistical methods and similarity concepts. A very welcome and unusual feature of this book is the section of the motion of turbulence to include such related topics as aerodynamic noise, the linearized theory of shear flow instability, chaotic dynamics and even a topic as remote from the traditional theory of turbulence as the propagation of weakly nonlinear waves. However, the price paid for this extensive range of topics is that no one subject can be developed in depth, and the reader seeking an in-depth account of a particular topic will have to use this book as a brief introduction to the basic concepts, and some of the relevant literature. It is extremely lucidly written, very readable, and carries the authority of two leading researchers in this area of fluid mechanics. It will be of value, not only for its intended market of post-graduate students, but also for those preparing a lecture course on turbulence and related topics.

NONLINEAR OSCILLATIONS IN PHYSICAL SYSTEMS, C. Hayashi, Princeton Univ. Press, Princeton, 1985, xii + 392 pp., $45.00.
NONLINEAR VIBRATIONS, G. Schmidt and A. Tondl, Cambridge Univ. Press, Cambridge, 1986, 420 pp., $103.50
Reviewed by R. Grimshaw, School of Mathematics, The University of New South Wales.

Since both these books cover similar territory I propose reviewing them side-by-side. Consider first the text by Hayashi. This is a reprinting of the 1964 monograph, which, at the time of its original publication, was a notable contribution to the field of nonlinear oscillations. It has stood the test of time very well. Although the intervening years have seen some dramatic developments in nonlinear differential equations, this text remains a readable and valuable account of what can now be regarded as the classical theory of nonlinear oscillations. Based on the analytical perturbation methods associated with Poincaré and the Russian school, this classical theory is an essential precursor to the modern developments, where the emphasis is on geometrical methods and numerical computation, and which have led to the discovery of such phenomena as strange attractors and low-dimensional chaotic systems. Hayashi's text first introduces the reader to the various analytical methods used, such as the Poincaré perturbation procedure, averaging and the principle of harmonic balance. These are used mainly in the search for periodic solutions but are also utilised in the discussion of some aspects of transient behaviour. Stability questions are addressed mainly by reduction to a Mathieu's or Hill's equation. Subharmonic and superharmonic oscillations receive a lot of attention, as does frequency entrainment, and understandably there is an extensive account of Hayashi's pioneering work on domains of attraction. Those old favourites, the Duffing equation and the Van der Pol equation make frequent appearances. Throughout there is a welcome emphasis on the comparison with experimental results, largely relating to electric circuits.

The text by Schmidt and Tondl covers very similar ground. Although only recently published it is an outgrowth of the work of both authors over two decades. Like Hayashi's text it contains no material on modern developments, and is firmly based on the classical theory of nonlinear oscillations. Some more recent topics are included, such as synchronization, turning into a variable resonance and random excitation. A good feature is the wealth of mechanical examples. Unlike Hayashi's text which is suitable for a wide range of research workers and graduate students interested in nonlinear oscillations, the text by Schmidt and Tondl is oriented more towards those whose interests lie in the particular field of mechanical vibrations.

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

In August 1985, the editors of the Bulletin of the Atomic Scientists published a special issue, - a 40th Anniversary Issue - recognising the dropping of nuclear bombs on Hiroshima and Nagasaki forty years earlier.

The few days represented by those days in 1945 provided the axe on which a substantial change in the modes of thinking about national and international relations took place. What we have seen since 1945 is an arms race on an unparalleled scale - in terms of destructive power.

The Australian Physicist, Vol. 24, 1987-Page 89
This book, whose content is 42 short essays, is based primarily, though not exclusively, on that August 1985 issue of the Bulletin of the Atomic Scientists. These essays range from reminiscences of the time spent at Los Alamos during the Manhattan Project, to critiques of the conduct of international negotiations, and relations, during the past 40 years, to serious though brief reviews, to statements of high idealism regarding ways of ending the nuclear arms race. Some sample titles are "How well they meant", "Japan's policies since 1945", "Forty years of Muddling Through", "U.S. and Soviet Security Perspectives", "History of the Nuclear Stockpile", "Secrecy and National Security" and "Politics, Technology and the Test Ban".

All authors are united on one point, namely, that the probability of all-out nuclear war must be made zero. But they are very divided on how this should be achieved. Indeed, essays from people who are employed in the U.S. weapons laboratories are very far from unanimous concerning the value of the task they carry out and its part in U.S.-Soviet relations.

The book contains some very wise, if not profound statements, an example of which - due to Alan Lightman - is "The weapons themselves are unthinking, but their creation and deployment spring from the human mind". I wish that the deployers of anti-nuclear bumper stickers would recognize this! It is not uranium that makes nuclear war, it is people! Unfortunately, the volume does contain some errors of fact, such as the assertion that plutonium is "a waste product of reactors, which becomes an explosive after it is separated from spent fuel in a reprocessing plant".

The volume contains many important essays, written from widely varying points of view by authors with widely varying backgrounds. It is a useful collection of facts and points of view regarding the "Nuclear Age", which mankind entered in that fateful week in 1945.

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Reviewed by P.H.J. McKellar, School of Physics, The University of Melbourne.

Both of these books are attempts to describe the excitement of recent developments in particle physics to the general reader, but would also be useful in giving physicists whose field is distant from particle physics an appreciation of the work of their colleagues, and as such are candidates for physics libraries as well as general libraries.

Davies' book is concerned to convey the basic principles of classical physics on which the future developments rest before taking up the story of atomic, then nuclear and then particle physics. At all stages he emphasizes the physical concepts involved, and does so successfully within the constraints he imposes. I can particularly recommend his discussion of virtual particle exchange as the mechanism of interactions between particles and his discussion of parity and CP transformations. Davies does allow himself the use of some high school mathematics, and is trying to convey the concepts involved as well as their history.

Ne'eman and Kirsh write at a similar level and aim at a similar audience. But with 100 more pages they can adopt a more leisurely approach. This enables them to spend more time discussing the history of the subject, and the experimental equipment involved. They have perhaps a little less flair for the apt analogy to illustrate concepts than Davies, but in my view this is more than compensated by the additional detail which conveys the scale of the subject.

To this review the feature which sets the Ne'eman and Kirsh book apart is the "marginal notes" describing the people involved and their reactions to the physics as it unfolds. I particularly enjoyed the account of Ne'eman, as an Israeli military attaché, presenting himself to Salam as a prospective PhD student and offering a reference from General Dayan! Also interesting is Maurice Goldhaber's observation that the relatively low incidence of radiation-induced cancer implies that the proton's lifetime must exceed $10^{16}$ years to reduce the self-radiation to acceptable levels. These notes bring the book alive, and make it a more enjoyable read.

Unfortunately, the simplifications necessary to tell a complicated story at a general level mean that distortions will often creep in. Davies associates radioactive decay with the second law of thermodynamics, in spite of the quantum nature of the former and the statistical nature of the latter. Ne'eman and Kirsh state that the speed of a classical electron orbiting the nucleus decreases as it loses energy and spirals in towards the nucleus, whereas the spiralling electron in fact would speed up. They also oversimplify the relationship between the strength of the Fermi weak interaction in neutron decay and the strength of the component processes $n \rightarrow p + e^- + \nu_e$ and as a result incorrectly estimate the latter, missing a chance to emphasize the essential unity of electroweak interactions.

Such distortions are readily correctable in later editions. In spite of them, either of these books could be recommended to the elusive "general reader". Davies will give him a better feeling for the concepts, and Ne'eman and Kirsh a better feeling for the history and the people who made it - so he would usefully read both.

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Reviewed by M.A. Green, School of Electrical Engineering and Computer Science, The University of New South Wales.

The above two volumes contain papers presented during the US-Japan seminar on 'Solid Phase Epitaxy and Interface Kinetics', held in Oiso, Japan in June, 1983.

The first volume concentrates on progress with techniques for growing thin crystalline silicon films on an insulating substrate, specifically silicon dioxide. This area of interest is because it offers the possibility of reduced parasitics in future generations of microelectronic circuits as well as the tantalising prospect of multi-layered 'three-dimensional' circuits. Progress with techniques for recrystallizing silicon layers deposited on its oxide in either polycrystalline or amorphous form is described, as are preliminary results describing the fabrication of devices and circuits on such layers.

The second volume tackles a more diverse range of topics. Most papers deal with the epitaxial growth of silicon on silicon or sapphire or the epitaxial growth of metal silicides and dielectric layers on silicon. The properties and applications of metal silicides also form a cohesive sub-unit within the volume.

The volumes give a good cross-section of some of the better work being conducted in the areas outlined as at mid-1983, particularly in the case of the Japanese work which dominates both volumes. The first volume would have benefited from an overall review of progress in the topic area covered, particularly if commissioned nearer the actual publication date of the volume. This would have been difficult with the second volume due to the diversity of its contents. Both volumes are of high production quality which may explain what appears to be the inordinately long delay between the date of the seminar and the above publication date.
POLICIES AND POLITICS

FASTS Excerpts from Newsletter No 4, Jan '87

FASTS Membership Expands

The New Year has started well for FASTS with decisions by the Australian Science Teachers' Association (ASTA) and the Australian Association of Mathematics Teachers (AAMT) to join FASTS. ASTA will join with a full Board Member whilst the form of AAMT's representation is still being worked out. The inclusion of these two societies within FASTS will enable FASTS to provide a comprehensive approach to Science and Technology education issues.

Education Issues Becoming Increasingly Important

Statements from industry representatives regarding the importance of improving Science and Technology (S&T) education surface fairly frequently. These were evident at the Budget Analysis Forum in November 1986. More recently at a meeting organised by the Commission for the Future, (23/1/87) Roger Banks from Telecom stressed the importance of promoting science and technology among young people.

ASTEC has established two committees on education. One, chaired by Prof D. Aitken (ANU), is looking at the "Capacity of Education". Another committee chaired by Prof F. Jevons (Deakin) is looking at informal education networks in private companies and in Adult Education. Prof Jevons is also on Don Aitken's Committee. FASTS has made informal contact with Prof Jevons and has alerted the Committees to the problems of shortages in supply of trained personnel.

Commission For The Future Seminars On S&T

The Commission for the Future organised a series of seminars on S&T during January with Prof D. Suzuki as keynote speaker. David Suzuki is Professor of Genetics, Department of Zoology, University of British Columbia and an international broadcaster on science and the environment. The Executive Director of FASTS, Dr D. Widdup attended two of the seminars, the first chaired by the Minister for Science Barry Jones, aimed at the S&T Community and the second chaired by Prof P. Fensham, Dean, Faculty of Education, Monash, aimed at S&T educators.

The overall message from Prof. Suzuki was that the human race must move towards greater equilibrium with nature and that scientists and technologists had a responsibility to help achieve this.

With regard to S&T funding Prof. Suzuki's statements (which were also broadcast on ABC's "The New View") would probably strike a sympathetic chord with various FASTS members:-

The community and political decision-makers need to realize that you cannot establish a research institute like a boot factory. You cannot pick an area, spend money and automatically expect to achieve results. The history of science and technology is that you cannot pick winners because you cannot predict what will come, what the discovery will be like. Therefore, you need to allocate the budget in such a way that you get the widespread development that comes in fields like biological science or medical science and that you can use the results of that development to develop the research institute.

FASTS Role In Education Issues

During 1987 FASTS hopes to promote education policies through its Board but also through public discussion. FASTS plans to provide an interchange of views of industry, professional interests, teachers and parents on S&T education.

To this end, Prof F. Smith, President of FASTS, and the Executive Director Dr D. Widdup met with members of the Australian Council of State School Organisations (ACSSO) on 12 January. ACSSO represents the 2.2 million parents of students at Government schools throughout Australia and former officials of ACSSO include Senator Ryan, Minister for Education; Joan Kirner, Victorian Minister for the Environment and Senator Giles, Vice-President of the A.L.P. ACSSO indicated that May would be a good time to institute discussions as future students will be making up their minds about subject choice by 1988. The ACSSO members present at the meeting expressed support for FASTS' proposals.

Minister For Education Responds on Overseas Post-Graduate Students

The Minister for Education, Senator Susan Ryan, in a letter dated 23/12/86 has responded to FASTS concerns about the effect on university research of the imposition of the Overseas Students Charge on students from overseas who have been awarded university postgraduate scholarships. The Minister replied that the 8.1% increase in funds for higher education was not achieved without some difficulty:- "Obviously this satisfactory result was only made possible by the adoption of some difficult measures. The variation of existing exemptions from the Overseas Students Charge was one such decision."

Australian Conferences

The Academy of Science's "Calendar of National and International Scientific Meetings in Australia" is not continuous. Conferences can be listed on "Australian Conferences" via the CSIRO AUSTRALIS information retrieval service. For further information contact Sue Harvey on (03) 418 7333 or Penny Braybrook on (03) 418 7335.

1988 Conferences can be publicized overseas through FASTS. Send details to the Executive Director.

Australian Airlines To Be FASTS Official Carrier

At its 13 January meeting the FASTS Executive agreed to negotiating an arrangement for Australian Airlines to be FASTS Official Carrier. The airline has offered to pay for two FASTS Board Meetings per year and provide discounts for FASTS members for international travel. More details will be available in the next Newsletter.

National Forum On Publishing In The Natural And Social Sciences Canberra 29-30 May 1987

The ACT Division of ANZAAS is planning this Forum to look at the state of publishing in these fields. Initial information will be based on a questionnaire being sent to editors. If you have not received a questionnaire and wish to be included please write to ANZAAS ACT Division, PO Box 723, Dickson ACT 2602 or call P. Judge on (062) 484527.

Information Requested on Down-grading of Libraries

The Australian Libraries and Information Council (ALIC) was set up by Cabinet in 1981 to advise Governments at all levels on the development of library and related information services in Australia. One of ALIC's current concerns is the effects of devaluation and inflation on the purchasing power of library budgets. The combination of these two factors is currently increasing the price of overseas books and journals at two to three times the increases in the CPI. ALIC fears that these effects must contribute to the progressive degradation of the services offered by libraries to all fields of scholarship.

If Member Societies have noticed a decline in library resources which is affecting the work of their members, they can bring this to the attention of P. Judge, PO Box 225, Dickson ACT 2602.

FASTS Full Council Meeting

In November 1987 FASTS will have a Full Council Meeting with representatives from all Member Societies. New Board Members will be elected. If you want to become more involved in FASTS, contact your Member Society.
Prepared by R. Payling, BHP, Port Kembla, for the A.I.P. Science Policy Committee.

The Commonwealth Department of Science has released both an Australian S&T Budget Brief for 1986 and the Science and Technology Statement for 1986-87. These two complementary publications provide a solid information base, for trends in science and technology in Australia. The former (S&TBB), which until 1985 was called Australian S&T Indicators Brief, is a vi + 34 page summary of Commonwealth expenditure on R&D which attempts to answer, in a compact form, the questions: "How much does Australia spend on R&D?" and "How does this compare with other countries?". The Science and Technology Statement (STS), on the other hand, is a x + 214 page document on Government research activities, directions and expenditures, for the various government departments, organizations, and socio-economic objectives. Commonwealth support for R&D continues to grow slowly, in real terms, with some areas such as Energy and Education, declining. Growth in Physics R&D is slow, while Australia's export/import performance in technology-intensive products continues to worsen.

Both publications adopt the OECD definition of R&D:

"Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications" (STS, p182).

For the ten year period 1976-77 to 1986-87 (estimated), the Commonwealth Budget Support for R&D in Australia has grown at an average "real" growth rate of 3.0% per annum, that is, after adjustment for the increase in the CPI (or GDP, which shows an identical trend for the period of interest). However, when compared with Gross non-farm Product the increase is only 0.2% per annum, or when compared with total Commonwealth outlays it is -0.6% per annum. Hence, while successive Budgets have shown a continuing commitment to increased support for R&D, it is apparent that R&D is not seen by government as a solution to Australia's economic woes since R&D has not been allowed to take a larger share of the Budget outlays (S&TBB, p1). Additional to these expenditures is approximately another 39%, not included above, which is estimated to derive from general university funding of university research (S&TBB, p6).

When this extra amount is included, the real long term growth rate in Commonwealth Budget support for R&D drops to 2.6% per annum. This 'long term' trend is shown in Fig. 1, for constant 1983/84 dollars. This trend naturally is a combination of trends and though, among these, other Commonwealth Support for R&D (in health, industrial R&D, etc) has increased significantly in real terms, the overall support for government Research Agencies has remained nearly static.

Of the four largest Commonwealth Research Agencies (by Budget allocation), the CSIRO allocation has grown in real terms by 1.2% per annum, the Defence Science and Technology Organisation by -0.7% per annum, the AAEC by -1.2% per annum, and the Antarctic Division by 10.6% (S&TBB, p9). Commonwealth Major R&D Granting Programs have grown by 5.6% per annum, with the Science component at 4.9% per annum. The largest Grants area, Health, has grown at 10.5% per annum and IR&D Grants at 7.3% per annum (S&TBB, p10). The ARGS announced grant allocation for 1976 to 1986 has increased at 4.3% per annum with the Physics component of this growing at 2.7% per annum (S&TBB, p12). These growth rates were estimated from the data, in the standard manner, by exponential regression, to avoid anomalies from individual years.

The total Commonwealth R&D support for 1986-87, including the general university research component, is estimated at $1770M (STS, p4). The cost of Commonwealth incentives and bounties for R&D is estimated at $137.7M for 1986-87, comprising 150% Tax Concession for R&D ($100M), 100% Tax Deduction for MICs (Licensed Management and Investment Companies) ($20M), and the Computer Bounty ($17.7M) (S&TBB, p11).

So far, the figures quoted have represented the years 1976-77 to 1986-87 and therefore represent an aggregate of activity by the former Liberal/National and the current Labor governments. Trends under the present government may be better estimated from short term trends, specifically the three year figures for 1984-85 to 86-87 (projected). Here, total Commonwealth support for R&D is increasing in real terms at 6.8% per annum compared with the 3.0% long term average, but Major R&D Grants Programs are down, 2.0% per annum compared with 5.6% per annum (S&TBB, p13). When the figures are considered by socio-economic objective, again in the short term, the big winners (greater than 10% per annum) are Construction (18.5% per annum) and Welfare (14.4% per annum), while the big losers (greater than -10% per annum) are Urban and Regional Development (-78.8% per annum), Other Community Services (-15.3% per annum), Overseas Development Assistance (-14.9% per annum), and Education (-11.10% per annum) (STS, p28-42).

Besides R&D in Australia, figures are also provided for the broader field of Science and Technology. The definition of S&T (STS, pp 183-4) includes: demonstration, design, technology transfer, policy studies, testing and quality control, patenting, data collection, training, etc. The Budget allocation for S&T runs close to twice that of R&D, which it includes, and is estimated at $2122M for 1987-88 (STS, p4).

When the Commonwealth Budget expenditure figures for
R&D and S&T are subdivided according to discipline, the Physics/Mathematics component of R&D is expected to be $90M (or 8.3% of total R&D) in 1986-87; but the Physics/Mathematics component of S&T is expected to be only $92M (or 4.6% of total S&T) in 1986-87 (STS, p 17). Thus, while Physics/Mathematics contributes significantly to R&D, its contribution to the non-R&D sector of S&T is quite small. The allocation of expenditure by discipline is, however, a difficult task for the Department of Science because expenditure is not normally collected according to scientific discipline. The Department must therefore rely on its interpretation of aggregate data, and the small Physics/Mathematics component of the non-R&D segment of S&T may simply reflect this interpretation. Nevertheless, it is important for both the government and the physics community to recognize that the applications and social benefits of physics are not restricted to R&D.

The Science and Technology Statement indicates a continued government emphasis on high technology and high employment sectors of the economy. The AIRDIS Scheme has been replaced with the GIRD (Grants for Industrial Research and Development) Scheme, which is designed specifically for new firms and projects of national significance unlikely to be undertaken by industry. Increased support for ARGS is aimed largely at new or improved equipment (STS, p 1), which should please physicists who have argued for some time the general ageing of university research equipment and the increased difficulty in obtaining state-of-the-art instrumentation because of massive price rises.

Finally it is instructive to compare Australia's R&D effort with that of other nations. The Science and Technology Statement comments: "all the large R&D performing countries (in the OECD, namely USA, Japan, FR Germany, UK and France) are also highly R&D intensive, and perform the greater part of their R&D in the business enterprise sector" (STS, p 44). Australia is normally considered among the medium R&D performers, however Table 1 shows a closer match with small R&D countries.

Currently, around 45,000 people (or 0.65% of the workforce) are employed in R&D in Australia (S&TBB, p 29); New Zealand also has 0.65% of its workforce in R&D (STS, p 45). For the median values shown in Table 1, government civil R&D is relatively uniform at about 0.6% of GDP, in going from large to small R&D countries. On a country by country basis, however, the figures vary from 0.17% in Greece to 0.91% in the Netherlands. When comparing Australia's efforts in R&D by socio-economic objective, Australia spends a much larger proportion than the OECD median on Agriculture and Environment and a much lower proportion on Energy, Defence and on a category called "Other" (STS, p 48).

Readers of the Australian Physicist will be familiar with a graph, showing Australia's technology export/import performance relative to the OECD, which Barry Jones presented in his article "Technology and Australia's Future" (Jones, 1983). The ratio of exports to imports for a wide range of selected technologies, including chemicals, plastics, machinery, electrical components, optical equipment and scientific instruments, etc., is plotted against per capita exports of these technologies. The graph Jones presented was from the Science and Technology Statement for 1982-83, and showed Australia near the bottom left hand corner. When it is recognised that the axes of the graph are logarithmic, the magnitude of Australia's poor position can be better appreciated. Since then, as the latest 1984 figures show, Australia's disastrous export-import decline has continued (STS, p 50). Australia now imports eight times as much as it exports in these technology-intensive areas. Australia ranks below all other countries included in the study, including Greece, New Zealand, Portugal, Turkey, and Yugoslavia, excepting only Iceland. During this period other countries which have shown similar rates of decline are USA, UK and Belgium, while countries with large improvements are Japan, Ireland, Yugoslavia and Portugal.

There is no simple explanation for Australia's relatively poor technology performance which can be discerned in our R&D expenditures relative to other countries. As one would expect from the many competing influences in the world economy, such as varying political systems, currency values, over-and under-production in certain goods, etc, plotting the relative performance of countries in the OECD against their expenditures in the various R&D categories does not lead to high correlation coefficients. There is, however, an obvious tendency for better performance to be associated with more R&D. For example, plotting per capita exports of selected technology-based goods against Business R&D leads to a

| R&D Figures for OECD Nations (based on Table 12, STS p45) |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                 | % Workforce     | Total R&D       | Business R&D    | Government R&D  | Government Defence R&D |
|                                 | Total R&D       | R&D (GDP)       | R&D (GDP)       | R&D (GDP)       | R&D (GDP)       |
| Large R&D Countries (Median)    | 1.23            | 2.54            | 1.42            | 0.58            | 0.40            | 0.14            |
| Medium R&D Countries (Median)   | 0.90            | 1.70            | 0.91            | 0.66            | 0.06            | 0.07            |
| Small R&D Countries (Median)    | 0.62            | 0.87            | 0.28            | 0.52            | 0.01            | 0.06            |
| Australia (1983)                | 0.65            | 0.96            | 0.19            | 0.66            | 0.08            | 0.03            |

1 Excluding Australia
2 GERD: gross domestic expenditure on R&D
3 Figures for Other R&D are not provided in STS p45, so the values shown are merely to balance the Business and Government R&D to give Total R&D.

Table 1. R&D Figures for OECD Nations.
correlation coefficient of 0.62 (for 22 points, with a 1% significance level). Likewise, there are many factors in Australia's ongoing poor performance in exporting technology-intensive goods. Two factors which have attracted considerable attention in recent years are the very small business expenditure on R&D in Australia and the lack of effectiveness with which Australian government supported R&D has led to new or improved technology-intensive products. More recent figures, than those available when the Science and Technology Statement 1986/87 was published, suggest that a dramatic turn around may be occurring in private sector R&D in Australia. The estimate of revenue foregone in 1986/87 through the 150% taxation incentive has risen from $100M to $140M. The estimate from private sector R&D expenditure for 1987 is now around $1100M, or nearly twice the amount for 1985, in constant dollars. These figures were supplied by the Department of Industry, Technology and Commerce and are based on 1985/87 taxation incentive registration data. Another promising sign is the 33% increase in employment in private sector R&D, from 8300 person years in 1982 to 11000 person years in 1985, recorded by the Australian Bureau of Statistics. There will naturally be a delay before this increase in R&D leads to new products and economic benefit but it is fortunate for Australia that the future is not all gloomy.

For all scientists concerned with trends in Australian R&D, the figures provided in both the Australian S&T Budget Brief, 1986 and Science and Technology Statement 1986-87 are of interest. For those who see a close relationship between R&D effort and prosperity, the growth in Australia's R&D efforts shown there must seem small compared with its dire export/import situation. There must also be concern amongst scientists for the way our scarce R&D resources are allocated amongst the various government sponsored activities and socio-economic objectives. Individual scientists will have their own opinion on whether the government should be spending more on R&D in agriculture, defence, energy, physics, etc., and, though the political and social consequences of such questions lie outside the scope of the two documents, the data they do provide will help support an informed opinion.

Reference:

The following Resolutions to the Council of the A.I.P came from the meeting:
1. That the Council of the A.I.P. take steps to get more support for students to attend Congresses and Workshops of the S.T.S.P. Group.
2. That the Council take steps to involve teachers of Physics at secondary and primary levels in Congress meetings. This might be achieved by having a more extensive 'Physics Education' workshop.
3. That Council promote the idea of 'billetting' students to reduce costs of their attendance at meetings.
4. That the S.T.S.P. Group recommends that the second half of each morning as well as the afternoons be made available in future Congress timetables for S.T.S.P. Workshops. (It is noted that the timetable for the Eighth Congress in Sydney in 1988 allows for this.) It is recommended that this become the rule.

The next scientific meeting of the S.T.S.P. Group will be held at the Australian Bicentennial Congress of Physicists to be held in Sydney in January, 1988.

B.J. Fraser.

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Solar Terrestrial and Space Physics Group Meeting

The first meeting of the group since inauguration in 1984 was held on August 27, 1986 at the 7th National Congress in Adelaide under the Chairmanship of Prof. K.D. Cole. A full agenda was tabled and discussed. Topics related to Australian space research (the Madigan Report; AUSSAT scientific packages) and future plans of the Scientific committee on Solar Terrestrial Physics (SCOSTEP).

A new chairman of the STSP Group, until the next Congress, was elected and there were a number of changes made to the membership of the Committee following the rule that about half the Committee should change every two years.

The new Committee includes B.J. Fraser (Chairman, University of Newcastle); L.T. Ball (University of Sydney); R. Boswell (A.N.U., R.S.P.S.); G.B. Burns (Antarctic Division, Department of Science); D.G. Cole (I.P.S., Department of Science); K.D. Cole (Immedate Past Chairman, La Trobe University); R.L. Dowden (New Zealand Representative, University of Otago); P.L. Dyson (La Trobe University); K.B. Fenton (University of Tasmania); P.G. Greet (Mawson Institute); W.K. Hocking (University of Adelaide); G. Nelson (Radioastronomy, C.S.I.R.O.) and D.G. Singleton (E.R.L., D.S.T.O.).
The GALA™ Laser System is a new collimated laser diode system from D.O. Industries, Inc. that can replace HeNe lasers for many applications, at a substantially reduced cost. This stand-alone system uses GaAlAs lasers with output power levels from 4 to 25 milliwatts and wavelengths from 750 to 830 nm. GaInAsP lasers can also be used to provide 4 milliwatts at 1.3 μm.

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- Fully tested and ready to use
- Direct modulation (Standard unit 100Khz-500Mhz, up to 2GHz on request)
- Long life (between 5000 and 50,000 hours depending upon power level)
- Small collimated beam (useful for components with restricted apertures)
- Flexible design (many wavelengths, power levels, and beam diameters)
- Meets BRH and FDA safety requirements
- 25 mm optic axis height (compatible with standard optical hardware)

To order the GALA™ Laser System, specify the power level, wavelength, and beam diameter as follows:

<table>
<thead>
<tr>
<th>Power Levels</th>
<th>Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
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</tr>
<tr>
<td>750nm</td>
<td>4 mw</td>
</tr>
<tr>
<td>780nm</td>
<td>4.8,16 mw</td>
</tr>
<tr>
<td>810nm</td>
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</tr>
<tr>
<td>830nm</td>
<td>25 mw</td>
</tr>
<tr>
<td>1300nm</td>
<td>4 mw</td>
</tr>
</tbody>
</table>

The order number for a laser system follows the format: GALA-PPP-P.D

where PPP = [075,078,081,083,130]
D = [4.8,16,25]

Example: a 780nm laser at 8 milliwatts with a 0.7x1.5mm beam would be a GALA-078-08-1.

More laser wavelengths and powers will be available soon. These include a low power laser (.5mw) at 680nm, a high power laser (90mw) at 830nm, and a low power stable mode laser at 780nm.
General News

Solar Steam will Compete with Conventional Fuels

The University of Sydney's Department of Applied Physics is contributing to a $304,109 project to install a solar steam process in two New South Wales hospitals. An initial grant of $25,000 has been released by the National Energy Research Development and Demonstration Council (NERDDC) through the Department of Health's HOSPLAN to begin the project.

The Department of Applied Physics has been subcontracted to supply the solar steam system to Canterbury Hospital by late 1987. This pilot project will be the first solar steam system of its kind to be installed in Australia. The second more extensive system, to be installed later at Parkes District Hospital, is expected to be able to compete economically with conventionally powered steam systems.

Dr. David Mills, Research Fellow in Applied Physics, developed the solar steam system which he says is far more cost-effective and simpler in design than other solar systems.

An eight sq m prototype of the system on the roof of the Physics Building has just been dismantled, and will be the guide for the revolutionary system planned for the roof of Canterbury Hospital. This will cover 200 sq m when installed. It will be capable of producing a peak of 70 kW. Steam produced will plug straight into the hospital's main steam line and the impact of the solar collector on overall fuel use will be monitored.

To ensure the economic viability of the solar installation, Dr. Mills has collaborated with A/Prof. V. Hall, Economics, on a number of computer-based financial evaluation studies of solar energy in relation to conventional energy sources. These show the solar steam system has great potential in industry to compete with conventionally fuelled systems.

Lucas Heights Fire

Report by the Minister for Resources and Energy, Gareth Evans Q.C., to the Senate.

The Cell

The fire began at about 5.45 pm 18 March in Hot Cell no. 2, which is located in Building no. 54 approximately 500m from the Hifar reactor building at the Lucas Heights facility. The hot cell is the size of a small room, measuring approximately 2.5m by 2m by 3.5m high, surrounded by approximately 1m of dense concrete and has a window at its front approximately 1m thick. The cell is used by operators using remote control apparatus to separate 99-molybdenum for the production of radiopharmaceuticals for distribution to hospitals throughout Australia.

The Fire

The cause of the fire was apparently (though this has yet to be confirmed by a formal inquiry) spontaneous combustion of an activated charcoal filter approximately 25 cm long and 7.5 cm in diameter - about the size of a rolling pin. The air supply to the cell was immediately closed and the filter was left to burn out. Initially the flames were approximately 60 cm high, but quickly diminished and the fire did burn itself out in about one hour. Because of the small size of the fire, AEAC officials decided to allow it to burn out, rather than opting to douse it with nitrogen gas. The fire was never big enough to raise any alarm, and reports that "fire engines fought the blaze" are more than a little astray. Any "smoke" that anyone saw coming from the facility was probably the normal phenomenon of steam coming off a water cooling tower.

Venting/Escape of Radioactivity

Such flames as were generated by the fire were vented from the Hot Cell through the Building's ventilation stack which has an elaborate filter system to contain radioactivity releases. There does appear to have been a small release of some biologically inert noble gases with short radioactive half-lives, possibly including krypton and xenon. The description "biologically inert" means that the gases in question do not interact with biological systems, and thus will not be taken up by humans or any part of the food chain.

In accordance with the authorisation issued by the NSW authorities pursuant to the NSW Radioactive Substances Regulations, very low levels of airborne radioactivity are routinely released from a number of stacks on site. This authorisation is set at levels that ensure that there is no hazard to members of the public or staff. The AAEC routinely operates well within this authorisation.

Measurements made to date indicate that the amount of radioactivity released as a result of the fire marginally exceeded routine levels, but was still within the NSW authorisation. There were therefore no health consequences to the public. This was confirmed by a Health Department officer who visited the site during the evening.

Contamination of Individuals

The operator present in the building at the time of the alarm and the shift manager both received extremely small amounts of contamination, being only slightly above normal background levels. The operator was contaminated on his fingers, possibly as a result of moving into the rear of cell area to close several doors, or through handling filter papers which were later used to test air in the vicinity of the cell and which would tend to concentrate any radioactive material present. The shift manager recorded some contamination in a small part of his hair, again only slightly above normal background levels, although it is uncertain at this stage precisely how it was acquired. In the case of both men the contamination was within the normal NHRMRC limits for radiation workers. The contamination was quickly removed by washing and posed no health threat. The operator opted to work on into the night to ensure that the deliveries of isotope due to hospitals the next morning could be made on time.

Reports

The authority has released preliminary reports, oral and written, and the AAEC has set up a Committee of Inquiry into the incident. The Committee was headed by the Chief of the Commission's Health and Safety Commission, Mr Jim Button, and included representatives of the State Health Department, the CSIRO and the Sutherland Shire Council.

Public Information

The only aspect of the incident to cause the Minister any concern was the public concern that was aroused as a result of insufficient information being readily available to callers as to what was going on: this led to at least one Sydney radio station apparently claiming that there was a Chernobyl-type graphic fire!

Because the scale of the incident was so small - presenting no public danger - the Lucas Heights Emergency Response Plan, Apcare (which involves, among other things, the rapid establishment of a media communications centre) was not invoked, and the State Emergency Service was not involved. Under normal operating procedures, the fire brigade was contacted, and under their procedures they in turn alerted the ambulance and police services - it was no doubt the presence of all of these agencies that aroused resident concern.

The AAEC has been asked to look at the possibility of establishing a special communications line to handle public enquiries - especially from local residents, and especially to cope with incidents which have the potential to arouse concern, even though they may be quite minor and certainly not such as to justify full scale emergency procedures.
**News from Asia**

**Third Asia Pacific Physics Conference**

We write to inform you that the Third Asia Pacific Physics Conference will be held on 20-24 June 1988 at the Chinese University of Hong Kong. The official First Announcement will be sent to you shortly. We hope that you will encourage and support members of your society to attend.

With the contacts already developed in the past two Conferences (Singapore, June 1983; Bangalore, January 1986) it is felt by many physicists that the time is now ripe for discussions to explore the possibility of creating a more formal institutional framework for regional co-operation. The idea of a Federation of Asia Pacific Physical Societies has been suggested. We should therefore like to seek your Society's views on this matter and to ask that your Society send a delegate to the Conference, at which a meeting will be called to explore this issue in depth.

With best regards,

C.N. Yang, Y.W. Chan, K. Young,
The Chinese University of Hong Kong, Shatin, NT, Hong Kong.

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**Notice from the Physical Society of Japan**

Members of the Australian Institute of Physics are welcomed to present their original papers at the 1987 Sectional Meetings of the Physical Society of Japan, which are to be held as follows.

**1st Sectional Meeting**

Date: September 30 - October 3, 1987.
Location: Utsunomiya University, Utsunomiya-shi, Tochigi-ken

Sections involved: Elementary Particle Theory; Elementary Particle Experiments; Nuclear Theory; Nuclear Experiments; Cosmic Rays

**2nd Sectional Meeting**

Date: September 29 - September 29, 1987.
Location: Tohoku University, Sendai-shi, Miyagi-ken.

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**Application Deadline for Presentation of Papers**


Presentations of papers at the meetings of the Physical Society of Japan by members of the Australian Institute of Physics are subject to the same rules as for members of the Physical Society of Japan, in accordance with the Agreement between these two organizations.

All enquiries for detailed information about these Sectional Meetings should be addressed to:
The Physical Society of Japan, Room 211, Kikai-Shinko Building, 3-5-8 Shiba-Koen, Minato-ku Tokyo 105, Japan.

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**Announcement**

ASPA News Vol. 2 No. 1 March 1987 has been published. It contains many well written and well chosen articles. Further details in the next issue of TAP.

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**THE PVD FRONTIER SEMINAR - 23 June 1987 - 9am to 6pm**

John Clark Gallery, University of New South Wales.

Physical Vapour Deposition (PVD) is a technique which is of major importance in many areas of materials science. The Commonwealth Department of Science and the School of Materials Science and Engineering, University of New South Wales, are jointly sponsoring a one-day seminar on PVD and its applications. The seminar is aimed at all materials scientists with an interest in PVD and related processes.

**Inclusions:**

- Introduction to PVD Processes
- PVD Processes in Microelectronics
- Applications in Optics
- Metalurgical Applications
- Computer Modelling of Thin Films
- Molecular Beam Epitaxy
- Applications to Solar Energy

**Registration:** The registration fee for the seminar is $50, which includes morning and afternoon tea, lunch, and cocktail hour. The closing date for registration is 16 June.

Enquiries: Dr Pancho Tomas, School of Materials Science and Engineering, University of NSW PO Box 1, Kensington, NSW 2033. Ph.(02) 697 4431.

**REGISTRATION FORM (ONE PER APPLICANT-please photocopy)**

**NAME:**

**ADDRESS:**

I enclose cheque for $50, payable to "Department of Science (The PVD Frontier)."

Mail the completed form to: The PVD Frontier Seminar, Sectoral Policy and Programs Branch, Department of Science, PO Box 65, Belconnen, ACT 2616.
Prizes

The European Physical Society's 1987 Hewlett-Packard Europhysics Prize has been awarded to Igor Yanson of the Institute for Low Temperature Physics and Engineering of the UkrSSR Academy of Sciences in Kharkov (USSR) for the discovery and exploitation of point-contact spectroscopy in metals.

The President of the Australian Academy of Science, Professor David Curtis, FRS, has announced that the winner of the 1987 Pawsey Medal is an astrophysicist from the University of New South Wales, Dr John Storey. Further details in the next issue of TAP.

* * *

Obituary

Peter Mason. 1922-1987

Emeritus Professor Peter Mason FAIP was first diagnosed with a brain tumour in 1985 and died on the 20th March 1987. Born in London in 1922, he graduated from the University of London in 1943 and later was awarded a M.Sc., Ph.D., and D.Sc. from the same University. In the last years of the war he worked on the military applications of quartz crystals for the Ministry of Supply. In 1946 he moved to the DSIR Building Research Station, in 1953 to the National Rubber Producer's Research Association and, in 1962, to the CSIRO Textile Physics Division in Australia where he worked on fibrous proteins and, in 1966, became first head of the Leather Research Section. It was in 1966 also that he was appointed to the Foundation Chair of Physics at Macquarie University. His subsequent research at Macquarie was in biophysics, first on muscle dynamics and later on the mechanisms of temperature regulation. He published about sixty research papers, ranging from his early papers on inorganic colloids, to studies of polymers such as rubber and plastics, then to biological polymers such as keratin and collagen, and finally to biological mechanisms, being the first to identify the cells in the hypothalamus which are the sensors involved in temperature control.

Peter was, of course, much involved with the setting up of physics teaching at Macquarie. One would be able to say that the style of physics teaching at Macquarie was innovative and that it reflected Peter's concern with the social implications of Science. In the event, however, physics teaching at Macquarie has always been perfectly conventional, putting slightly more emphasis than is usual on academic rather than applied physics and showing no more concern than any other Australian physics department with the present or past interactions between science and society. Peter's only enduring academic influence seems to be a couple of meta-science courses taught, after Peter's example, by physicists rather than by social scientists, plus a modest research effort in biophysics.

Peter's absorbing interest, in his later years, was "Science-in-Society". He gave much of his time to many a movement and committee in this area, writing, lecturing and broadcasting a great deal, endlessly consulting and encouraging his many extra-university contacts, active in SANA and, in his last years, a member of Barry Jones's "Commission for the Future". His major legacy is his broadcasts and the books which grew out of them. That clear engaging voice in the broadcasts and that lucid easy style in the books are models which few can match. He could break through the constrictions of scholarship and engage the attention of all. Time and again I have had citizens or students say to me; "You know Peter Mason! I never miss his Science Show programs." He was not so successful, however, in breaking through the constrictions of conventional 1930s-Marxist thought. Early exposure to Bernal and Haldane is not easily overcome.

His books are an impressive legacy and deserve more notice than they have ever received in the physics community. The first was "Genesis to Jupiter" (ABC Sydney, 1977), a short book representing a scaled-down version of the Marxist thesis that the Scientific Revolution was inspired by the navigational needs of the early capitalist society in which it originated. Those of us who prefer Alexander Koyré and Michael Polanyi to Boris Hessen and J.D. Bernal are not too enthusiastic about "Genesis to Jupiter", but it serves its purpose as an easy account of one side of a major modern debate.

Next was his history of Rubber: "Cauchu - The Weping Wood" (ABC Sydney, 1979). For me, at least, it was his most successful book. Many of us will always remember Peter's voice telling the terrible story of the exploitation in the Congo and Amazon, praising the courage of Roger Casement and burning with indignation at the shame of his death. The combination of polymer physicist with eloquent humanist was a triumph.

In "The Light Fantastic" Peter attempted the same sort of treatment for light. It was not so successful. The nature of light (as Einstein remarked) is the most profound point in physics, while its technological products (domestic lighting, microscopes, cameras), though central to our lives, do not present the same motive and cue for passion as did the story of rubber. All the same, how pleased one would be if our physics undergraduates could be persuaded to read the book to put a bit of flesh on the academic bones of their lectures on optics.

Peter's next book was "Blood and Iron" (Penguin 1984), the story of iron and steel. A literary critic might say it was late Mason, where new techniques of presentation are explored with a mature and confident style. It was, in essence, a novel in which the technology of steel rules the lives of many characters. When I read it I told him that I was confused about where historical fact ended and fiction began. "Good", Peter replied, "that's just the effect I intended." I was inclined to be suspicious, but I can see how skilfully the book was written and how effectively it brings out the central point that technology shapes our lives.

Finally, one must pay tribute to Peter's urbanity and personal charm. I am sure that he had dozens of friends who will regret, as I do, that we have lost one of the people that we most enjoyed talking to. He could agree with warmth or disagree without trace of rancour. In his last hard year he never seemed bitter or afraid, always calm and cheerful, almost as though he found it quite intriguing to know what it was like to have much of your brain function destroyed. Few could have endured it so well.

Arthur Pryor.

THE UNIVERSITY OF SYDNEY

Lectureship (Tenurable) Reference no. 3/09 School of Physics

The position is that of Lecturer in the Applied Physics Department within the School of Physics. The appointee will join a group currently investigating applications of spread spectrum techniques. The project has a commercial interest and the appointee should have a strong interest in University industry interaction. Future directions of research will lie in digital signal processing techniques, and a background in electronics, signal analysis and current computing technology is required. The appointee will be required to participate in the undergraduate and postgraduate teaching programmes of the School of Physics with special emphasis on electronics, data acquisition and signal processing.

Further information from the Head of the School of Physics on (02) 692 2537.

Appointments to Lectureships have the potential to lead to tenure and are usually probationary for three years.

Salary range: $27,859 - $36,600 per annum

Applications, quoting reference no., including curriculum vitae, list of publications and the names and addresses of three referees to: The Registrar, University of Sydney, NSW 2006, by 22 May 1987.

The University reserves the right not to proceed with any appointment for financial or other reasons.

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GENERAL: The Division undertakes research in applied physics related to problems in industry and the community and collaborates with industry in exploiting promising developments. Research includes programs in optics, cryogenics, electronic, magnetic and thermal properties of materials, discharges in gases, thin-film and surface physics, including plasma etching and spectroscopy. The Division is also responsible for the maintenance of the Australian Standards of physical measurement and undertakes research work in measurement science.

Extensive facilities are available for theoretical modelling. They include Cyber 205 and 840 systems (CSIRONET), and an in-house VAX system with associated graphics work station.

DUTIES: To undertake theoretical investigations in collaboration with the Division’s experimental research and development programs in the above areas of research, to undertake computational modelling of physical and chemical processes and to give theoretical support across the range of the Division’s activities.

QUALIFICATIONS: A PhD degree in physics, applied mathematics, materials science, computer science or engineering, or equivalent qualifications, and proven research ability. The successful applicant must have a record of successful interaction with experimental research and development teams, and must have demonstrated an ability to move into new areas of physics as required.


APPLICATIONS: Stating relevant personal particulars, including details of qualifications and experience, the names of at least two professional referees and quoting reference No. A4306, should be directed to:

The Chief
CSIRO Division of Applied Physics
PO Box 218
LINDFIELD NSW 2070

by 21 May 1987

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The above position is funded by the A.R.G.S. to work with Dr G.C.Joshi on the project "Phenomenology of Elementary Particles". Applicants should have a Ph.D. in theoretical physics with a background in particle physics. An appointment may be made for up to two years.

Enquiries may be directed to:
Dr Joshi, School of Physics,
Ph. (03) 344 5088; FAX (03) 344 5104;
Bitnet Address: U6407531@RVAX.DN.MU.OZ.

Salary up to $26,112 within the range $24,014-$27,507 per annum.
A contribution towards the cost of travel to and relocation in Melbourne may be made to an appointee from interstate or overseas.

Further printed information regarding details of application procedure and conditions of appointment is available from the Appointments Officer (Academic).

Applications including names and addresses of at least three referees and quoting position number 640 A780 should be addressed to:
The Director, Personnel Services,
The University of Melbourne,
Parkville, VIC 3052.

Applications close on 31 July 1987

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Overseas Fellowships

Application forms are now available from:

International Exchanges Officer,
Australian Academy of Science,
GPO Box 783, Canberra, ACT 2601.
Ph: (062) 47 3966.

for the following:

- Visits to Japan '88/89,
- Visits to China '88/89.
- Visits to U.K. '88.

Conferences and Meetings
1987

           The Conference Manager, CSC '87, The Institution of Engineers, 11 National Circuit, Barton, ACT 2600.

Jun 30-Jul 2 3rd Nat. Space Engineering Symposium, Canberra.
           Conf. Manager, Institution of Engineers, 11 National Circuit, Barton, ACT 2600.

           Course Secretary, QSEARCH, Queensland Institute of Technology, GPO Box 2434, QLD 4001.

           Mrs D. Uherkova, Gorheko xam. 23, 112 82 Prague 1, Czechoslovakia.

Jul 8-9  Technology and Exports, Brisbane.
           Lee Rystrand, The Institute of Engineers, Australia, 11 National Circuit, Barton, ACT 2600

Jul 14-16  Automated Vision Technology, Caulfield East.
           Dr C.F. Osborne, Applied Physics Dept, Chisholm 1 of T, 900 Dandenong Road, Caulfield East, VIC 3145.

Jul 20-Aug 14 Radioisotope Course for Graduates, Lucas Heights.
           The Principal, Australian School of Nuclear Technology, Locked Mail Bag No. 1, Menai, NSW 2234.


Aug 3-8  International Symposium on Experimental Gravitational Physics, Guangzhou, China.
           Dr D. Blair, Department of Physics, The University of W.A., Nedlands, W.A. 6009.

Aug 4-12  4th International Symposium on World Trends in Science and Technology Education, IOSTE, The Netherlands
           J. van Trommel, P.O. Box 2061, 7500 CB Enschede, The Netherlands.

Aug 8-10  Neutron Scattering Symposium, Sydney.
           The Secretary - ANBUG, C/O AINSE, Private Mail Bag, P.O., Sutherland, NSW 2232.

Aug 10-14  7th EPS General Conference, Helsinki.
           EPS Secretariat, PO Box 69, CH-1213 Petit-Lancy 2, Switzerland.

Aug 12-30  XIV Int. Congress and General Assembly, UC, Perth.
           Dr E.N. Maslen, Crystallography Centre, The University of W.A., Nedlands, WA 6009.

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

Aug 17-21  ICAME87 - International Conference on the Applications of the Mössbauer Effect.
           ICAME87, Department of Physics, Monash University, Clayton, VIC 3168.

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

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

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

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

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

Sept 14-18  14th Int. Conf. on X-ray and Inner Shell Processes, Paris.
           Secretariat, X87-Pierre Lagarde, LURE, Bâtiment 209 d, Université Paris-Sud, 91405 ORSAY Cedex, France.


Sept 26-29  General Physics Meeting, Physical Society of Japan, Tohoku University.
           Physical Society of Japan, Room 211, Kikai-Shinko Building, 3-5-8 Shiba-Koen, Minato-Ku, Tokyo 105, Japan.

Sep 30-Oct 3  Elementary Particles Meeting, Physical Society of Japan, Utsunomiya University.
           Physical Society of Japan, Room 211, Kikai-Shinko Building, 3-5-8 Shiba-Koen, Minato-Ku, Tokyo 105, Japan.

Oct 6-9  Int. Conf. on Electrical Machines and Drives, Adelaide.
           Conf. Manager EEIC87, Institution of Engineers, 11 National Circuit, Barton, ACT 2600.

Nov 12-13  Annual Conference of the Australian Acoustical Society, Hobart.
           Mr S.E Samuels, AFRB, PO Box 156 (Bag 4), Nundawading, VIC 3131.

Nov 15-19  International Conference on Lasers, Xiamen, China.
           Professor Deng Xi Ming, P.O. Box 8211, Shanghai, China.

Dec 6-9  12th Aust. Conf. on Optical Fibre Technology, Surfers Paradise.
           Conference Secretary, IREE, Unit 3, 2 New McLean Street, Edgecliff, NSW 2027.

Dec 7-11  10th Int. Conf. on Lasers & Applications, Lake Tahoe.
           Lasers '87, P.O. Box 245, Mclean Va 22101, U.S.A.
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Specifications

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