THE AUSTRALIAN PHYSICIST

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PRESIDENT'S COLUMN

There can be few members of the AIP who have not heard of the oppression of physicists and indeed scientists as a whole in a number of countries. For example, there is in the Soviet Union a group of scientists, the "Refusniks", mostly Jews, who wish to emigrate from the Soviet Union. Also, there seems to be evidence of many physicists having lost their positions recently in Argentina. The American Physical Society (APS) has a Panel on Public Affairs (POPA) with a Committee on International Freedom of Scientists (CIFS). Professors B. R. Cooper and J. Parmentola of the CIFS reported in 'Physics Today' for August, 1978, page 9. The Council of the APS at its meeting on 18th November, 1978, adopted a proposal on Human Rights of Scientists and the details are given in the APS Bulletin, Vol. 24, February, 1979, page 93. The Science Policy Committee of the AIP has discussed this topic at several meetings in 1979 and if the consensus can be achieved on such a difficult and emotional topic, it was along the following lines. We would like to see all scientists have freedom (1) to pursue their own scientific interest, (2) to communicate the results of their work either through personal contacts or through scientific journals, and (3) to follow the social consequences of their own work.

The SPC also felt that it would like scientific judgements to be made on scientists by scientists; thus, it felt that scientific grants should be awarded as the results only of scientific judgements. The SPC recognize that such statements would always have to be viewed in the light of constraints that may operate on an individual scientist such as might arise from commerce, economic conditions (e.g. patents) or security.

However, the members of the SPC in saying these things were conscious that they were very broad generalizations to which probably few persons could object, as indeed were the similar statements from the APS. Could we in Australia go further? We thought that we could. There was no one known personally to any member of the committee who could be called oppressed but we thought that some of us in the APS may know of actual cases from their own speciality. If the details could be given to us, the SPC felt that it could write, perhaps on its own behalf, to the head of the laboratory or institution. A letter of professional support and encouragement to the named person might also be possible. Please send details to me at the Science Centre, Sydney.

There was a measure of concerted action taken in Britain in the 1930's over refugees from Europe; a description is given in 'Rutherford' by A. S. Eve (1939) page 375. At present, a long-term aim to accept scientific refugees into Australia seems to have great difficulties in its way.

THE ROCKHAMPTON CONFERENCE

At the recent Executive Meeting of the AIP on Tuesday, 10th July, 1979, I was very pleased to hear such a good report on the Applied Physics Conference at Rockhampton from 3rd to 6th July. With about 150 persons attending, very well distributed over institutions in Australia, it has proved an admirable addition to the increasing number of national activities of the AIP. In addition to the technical scientific sessions at the conference, there were several lectures on science policy.

From the vigorous support of the Conference through the lectures, it seems reasonable to expect that this year's conference could be seen as the first of a series of applied physics conferences. Such a conference cannot be organized by the AIP Executive; it depends on an enthusiastic and active local committee making the offer and working steadily over many months. The physics community is grateful for the hard work done by the local committee at Rockhampton which has so well started the possibility of the applied physics conferences. I understand that there is a possible offer for a place as a successor to Rockhampton; if I could offer a suggestion to a new organizing committee, it might be worth considering having the applied physics conferences every two years, alternating with the National Congresses. The next National Congress, the Fourth, will be held in August, 1980 at Melbourne University; would the organizers of the next Applied Physics Conference consider 1981, perhaps the second vacation in August, for the time of the Conference?

H C Bolton
CORPORATE MEMBERSHIP OF THE AIP

QUALIFICATIONS

From the AIP Membership Committee: J. G. Collins (Hon Registrar), W. R. Blevin, R. E. Collins and H. J. Goldsmind.

This paper reviews the present entry requirements for Corporate Membership of the Australian Institute of Physics. A number of possible alterations to these requirements and to the whole membership structure of the AIP are discussed. Some of these topics will be considered by the Council of the Institute in September. The members of the AIP are invited to express their views on these alternatives.

PRESENT REQUIREMENTS

The Articles of the AIP specify the qualifications for membership as follows:

Article 7.

Every candidate for admission or transfer to the grade of Fellow shall either—
(a) have obtained a degree of Doctor of Philosophy in physics recognised for the purpose of this clause by the Council or shall have in the opinion of the Council attained an equivalent standard in his knowledge of physics and his general education; and
(b) have had such experience, for at least five years after obtaining that degree or attaining that standard, in the practice of physics or its applications or teaching of physics at such a level of responsibility as shall satisfy the Council,
or alternatively—
(a) be a Member or meet the requirements for admission or transfer to that grade; and
(b) have had such experience, for at least six years additional to that specified in the next succeeding clause as a requirement for the grade of Member, in the practice of physics or its applications or teaching of physics at such a level of responsibility as shall satisfy the Council.

Article 8.

Every candidate for admission or transfer to the grade of Member shall either—
(a) have obtained a degree of Master of Science in physics recognised for the purpose of this clause by the Council or shall have in the opinion of the Council attained an equivalent in his knowledge of physics and his general education; and
(b) have had experience, for at least two years after obtaining that degree or attaining that standard, in the practice of physics or its applications or teaching of physics at such a level of responsibility as shall satisfy the Council,
or alternatively—
(a) be a Graduate or shall meet the requirements for admission or transfer to the grade of Graduate; and
(b) have had experience, for at least four years additional to that specified in the next succeeding clause as a requirement for the grade of Graduate, in the practice of physics or its applications or for the teaching of physics at such a level of responsibility as shall satisfy the Council.

Article 9.

Every candidate for admission to the grade of Graduate shall—
(a) have obtained a degree of Bachelor or a diploma with physics as a major subject recognised for the purpose of this clause by the Council or shall have in the opinion of the Council attained an equivalent standard in his knowledge of physics and in his general education; and
(b) have had experience, for at least one year after obtaining that degree or attaining that standard, in the practice of physics or its applications or in the teaching of physics at such a standard as shall satisfy the Council.

Article 10.

Notwithstanding the provisions of these articles the Council may, in exceptional circumstances, admit candidates who do not meet the requirements of the three last preceding articles to the grades of Fellow, Member or Graduate.

Over the past year, the AIP Membership Committee has been considering several possible changes to these requirements. The need for change arises from a variety of reasons, ranging from mechanical difficulties in processing applications to assessment of the precise levels of achievement required for Membership and Fellowship. There is also some concern about the desirability of splitting the membership structure into grades.

The Membership Committee feels that these deliberations would benefit greatly from inputs from the membership of the AIP as a whole. You are therefore earnestly invited to consider the possible changes discussed here and to let us know what you think.

QUALIFICATIONS FOR GRADUATE MEMBERSHIP

In order to qualify for Graduate membership, the applicant must have had at least one year's experience in physics after obtaining his degree. This requirement for post-degree experience before admission to Graduate is consistent with similar requirements for Member and Fellow. Its purpose is presumably to ensure that the candidate is, or has been, a practising physicist at the relevant level. This requirement, at the Graduate level, has resulted in several difficulties in assessing membership applications.

(a) A pass graduate wishing to join the Institute immediately after graduation must become an Associate for one year, and then transfer to Graduate. This is a cumbersome procedure, involving significant paperwork, changes to the Register, mailing list, etc. Moreover, it may act as a disincentive to potential members
because of the complexity of the process. In the past, the Institute has partially avoided this problem by not requiring Student members to transfer to Associate immediately after graduation. They can acquire a year's experience and then transfer directly to Graduate.

(b) Applicants with part-time degrees pose a particular problem. In some cases, these applicants possess significant experience at a high level by the time that they obtain their degree. At present, the AIP requires that they be admitted as Associates for one year, during which time they often continue doing exactly the same kind of work that they did before graduation.

(c) A problem similar to (b) will occur with applicants graduating from "sandwich" courses offered by many CAE's. These applicants will usually have obtained one year's experience during the completion of their course. A typical sandwich course requires six months experience after 1½ years' study and a further six months after 2½ years' study. This work, and particularly that done in the latter period, is often indistinguishable from that normally done by a graduate.

(d) The present employment climate poses problems for graduates who are unable to obtain work at professional level immediately after graduation. As the rules are presently interpreted, such applicants must remain as Associates until they can obtain suitable employment. Applicants are thus discriminated against for a reason over which they have no control. In some recent applications the Membership Committee, after investigation, has accepted employment in sub-professional positions as meeting 'a standard as shall ... satisfy the Council'. The period of such experience has usually been significantly greater than one year.

Article 10, stated above, provides a way of by-passing these difficulties. The Membership Committee believes, however, that this Article should be invoked infrequently and not for recurring problems.

An alternative approach would be to delete Article 9(b) from the Articles. This would remove completely the requirement for post-graduate experience in order to be admitted to Graduate membership of the AIP.

The removal of the experience requirement would resolve all the problems discussed above. Specifically:

(a) The procedure for a new graduate joining the Institute would be simplified and streamlined.

(b) Applicants who have obtained experience prior to or during the acquisition of a degree could become Graduates immediately upon completion of their degree.

(c) Candidates who are unable to obtain work at a professional level would not be disadvantaged.

Despite these benefits, the removal of the experience requirement does represent a lowering of the standard for entry to Graduate membership of the AIP. This could be a cause for some concern, particularly since the qualification of GAIP might be regarded in some areas as the equivalent of a degree from a recognised tertiary institution. There seem to be two areas where this equivalence may be relevant.

(1) The AIP occasionally receives applications for Corporate membership from persons without formal tertiary qualifications. In at least one such case, it appears that the granting of membership has assisted the promotional prospects of the applicant.

This situation is not relevant to the changes proposed here. Applicants in this category would always have had considerable experience and have usually made outstanding contributions in their field of expertise. Since they do not have a degree, they are admitted under Article 10, not Article 9.

(2) The Registrar frequently receives requests from Government agencies for information about whether the AIP recognises a particular tertiary qualification as acceptable for Graduate membership. It could be construed, therefore, that GAIP is recognised as equivalent to a degree by these agencies.

Extensive inquiries have revealed that this is not, in fact, the case. The area of Federal Government which deals with these matters is the Public Service Board. The Board was approached and has stated that no equivalence is drawn between GAIP (and a whole range of other professional society grades) and a degree. One of the main inhibiting factors in drawing this equivalence is the experience requirements! The Board sees its requirement of a degree as a minimal qualification. The approaches made to the AIP are in the nature of consulting an expert body in order that records can be kept up to date or for the purpose of evaluating a particular applicant.

QUALIFICATION FOR FELLOWSHIP

The ad hoc Committee that was set up in 1972 following the 20th Council meeting have a summary of acceptable qualifications which, for the grade of Fellow are:

(a) DSc.

(b) PhD plus five year's experience

(c) MAIP plus six year's experience

(d) Grad AIP plus ten year's experience

(e) Fellow of the Institute of Physics.

The Institute's General Information booklet also states:

"The standard required by Council for Fellowship is hard to define, particularly in regard to level of responsibility. Whilst not wishing to imply that university degrees are used as the only yardstick, the minimum standard for Fellowship may be taken to be somewhere between the equivalence of PhD and DSc as representing a professionally qualified person with a continuing record in physics at an appropriate level."

There is some concern that the Institute may be conferring Fellowship on members who have done little to justify their promotion to the highest of the corporate grades (other than that of Honorary Fellowship). An opinion exists that admission to Fellowship should recognise a substantial contribution to physics or its applications. It is often stated that Fellowship of the Institute of Physics (London) is of the same status as the Degree of Doctor of Science but recognises achievement in physics that is not necessarily of an academic nature. Perhaps the Australian Institute of Physics should set its sights on a similar high standard.

The Articles, of course, must be interpreted according to the direction of Council. The key words seem to be "... such experience ... in the practice of physics or its applications or the teaching of physics as such responsibility as shall satisfy the Council."

It has been the practice of the Membership Committee, following a Council directive, to be somewhat more critical in evaluating experience in secondary teaching than in other fields.
Although it may be agreed that the standard for FAIP might be different from that of F.Inst.P., it is surely desirable that Fellowship of our Institute should recognise achievement rather than just length of service. The standard or achievement should surely be such that only a minority of the membership of the Institute (say one-third) should be expected to reach it. It could be argued that there is some value to the Institute in retaining the grade of membership of Fellow if it recognises merit but no value (other than in an increased subscription) if transfer to the grade is almost automatic.

Should the Membership Committee be more critical in the recommendation of applications for Fellowship? Should substantially less than half of the membership be expected to reach the appropriate standard?

ELIMINATION OF GRADES
The above proposals represent relatively small changes to the existing system. An alternative, and rather more far-reaching possibility which has been discussed is to eliminate completely the different corporate grades of membership. The three existing grades would be replaced by a single grade with minimum entry requirements, perhaps with a sliding scale of fees.

The argument in favour of a single grade of membership is essentially that the existing grades of Member and Fellow do not bring to their holder very much in the way of tangible benefits and have limited significance as a qualification either inside or outside the Institute. The proposal to increase the entry requirements for Fellow would reduce the strength of the last argument.

AMALGAMATION OF GRADUATES AND MEMBER GRADES
A final possibility being considered is to amalgamate the grades of Graduate and Member into a single grade. With this structure, the combined grade would represent the “career” level to which all qualified physicists would be admitted. The award of Fellowship would become a distinction to be given solely on the basis of achievement. The guidelines for such an award would be along the lines of those discussed above.

COMMENTS PLEASE
The Membership Committee seeks the opinions of the membership of the AIP on these matters. The need for changes arises partly out of problems that the Committee has experienced, but, more significantly from a realisation of the changing structure of science, technology, education and employment in Australia. Undoubtedly there are important arguments that are not included here, comments that should be made, even possibilities that we have not considered. Any change in the membership requirements would require a change in the Articles of the AIP. This is not something that should be done without a full debate of all possibilities.

Please write to the *Australian Physicist* with comments, criticisms, and suggestions.

**Items of Interest from Executive**

**CHINA VISIT**
The Institute is organising a visit by a group of physicists to the People’s Republic of China early in the New Year. More than a dozen people have so far indicated their interest and inquiries can be directed to Professor Terry Sabine at the NSW Institute of Technology. He would also like to hear from anyone willing to share the burden of organisation.

**EDUCATION COMMITTEE**
Discussion has once more arisen over the future of the National Education Committee of the Institute. It has been strongly suggested that the national committee be disbanded and its activities revert once more to a state basis, since many of its concerns have a state orientation.
The matter will be fully aired at Council in September.

**DEATH OF J. C. JAEGGER**
Members will be saddened to hear of the recent death of Professor J. C. Jaeger, a Fellow of the Institute and a leading figure in Australian physics for many years.
The 50th Jubilee Congress of the Australian and New Zealand Association for the Advancement of Science will be held on the campus of the University of Adelaide, May 12–16 next year, 1980. Some thirty sections covering Physical, Biological and Social Sciences will be involved and a number of specialist societies will be holding meetings concurrently so that worthwhile cross fertilization is assured.

Section 1 (Physics) has as President, Dr R. W. Crompton of the Research School of Physical Sciences, Australian National University, as Chairman, Professor I. E. McCarthy of the School of Physical Sciences of the Flinders University of South Australia and as Secretary, Dr. B. H. Horton, Department of Physics of the University of Adelaide.

The programme will take the form of Section meetings in the morning of each day with interdisciplinary symposia and/or tours of interest in the afternoons.

Section 1 will provide three formats for presentation of papers. The morning meetings will consist of Review Papers presented by invited speakers allowing time for discussion in each case. Opportunity for more concrete interchange of information will exist at Poster session presentations which will be on view for the full day of the relevant topic and have one of the authors in attendance for one set hour during the afternoon. Authors may either present a brief summary of work intended for publication elsewhere or supply preprints for possible inclusion in bound proceedings of the Congress.

A list of the various sessions with prospective invited speakers is given below and those wishing to contribute via the poster sessions are invited to send one page abstracts to the section secretary by 31st August, 1979.

(a) Nuclear Fission and Alternative Energy Sources occupy two morning sessions in conjunction with Section 5 (Engineering).
(b) Physics Education in Schools, Tertiary Institutions and Continuing Education groups. Professor Robert Karplus, Professor M. Brennan, Mr B. Webber.
(c) Physics of Space and Time Archaeometry and Astrophysics. Professor H. S. Green, Dr D. S. Mathewson, Professor J. R. Prescott, Professor D. Holten.
(d) Quantum Physics of Molecules, Atoms and Nuclei. Professor C. A. Hurst, Professor B. H. J. McKellar, Professor I. McCarthy and Professor E. Weigold.
(e) The Earth, the Sea and the Sky – Seismology, Oceanography, Meteorology and Ionospheric Studies. Professor K. Lambeck, Dr B. H. Briggs, Dr R. Radok.

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**NEWS FROM THE DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION**

DSTO scientists at RAN Research Laboratory, Sydney, and Weapons Systems Research Laboratory, Salisbury, SA have been studying the ocean off the eastern coast of Australia. They have observed an oceanic front, somewhat analogous to an atmospheric front, which occurs between Australia and North Island, New Zealand. It has been named the Tasman Front. Its position varies. It separates the cooler Tasman Sea water from warmer water to the north. Its shape is somewhat irregular but possesses a periodicity with a wavelength of several hundred kilometres. The periodic structure appears to move westwards along the front, causing eddies to be formed in the ocean near the coast of Australia. Several eddies are formed each year. The investigations of the front have been carried out using RAAF Orion aircraft, Navy ships and a NASA satellite.

The Defence Science and Technology Organisation was very well represented at a symposium on "Structural Fatigue as a Design Factor" held in Brussels, in May, by the International Committee on Aeronautical Fatigue. Five of the twenty-two papers were Australian and four of these came from Aeronautical Research Laboratories, Melbourne. These four papers were delivered by Dr G. S. Jost of ARL, who also prepared and delivered the Australian national review.

Mr E. R. Harrison, head of the metrology group at Materials Research Laboratories, Melbourne, was nominated by CSIRO to be attached for two months, April and May, to the Singapore Institute of Standards and Industrial Research. He was supported under the terms of a contract between the United Nations Development Program and the University of Wisconsin. His assignment was to upgrade the capability in physical metrology at the Institute, train local staff and make recommendations for development over the next five years, to meet the needs of the rapidly expanding industrial activities in Singapore.
LASER FUSION AND FUTURE ENERGY SOURCES

— SOME RECENT RESULTS

HEINRICH HORA, Department of Theoretical Physics, University of N.S.W.

In this second part the recent theoretical developments in linear fusion are reviewed, with some comment on the way these will influence research.

Part 2

4. NONLINEAR PLASMA DYNAMICS AT LASER IRRADIATION

In order to summarise the processes involved in laser plasma interaction for the conditions of laser fusion we will consider the basic equations of conservation on which numerical studies and analytical considerations are based. We follow here a recent monograph.\(^{38}\) The equation of conservation of mass is the equation of the plasma continuity in terms of the plasma ion density \(n\), the plasma velocity \(v\) and ion mass \(m_i\)

\[
\frac{\partial m_i n}{\partial t} + \nabla \cdot (m_i v n) = 0
\]  

(4.1)

where no generation of mass is assumed and a more general description for electrons and ions of a plasma has to be formulated appropriately. This equation of continuity results in no special complications for laser pulse interaction. The equation of energy conservation

\[
\frac{\partial}{\partial t} \left( \frac{m_i v n v^2}{2} \right) = \frac{\partial}{\partial t} (m_i k T) - \nabla \cdot (\gamma n v T) + W
\]  

(4.2)

describes the change of the kinetic pressure of the plasma in terms of the change of the static pressure given by a temperature \(T\) if \(Z\) is the number of charges on the ions, the change of thermal conductivity given by a constant \(\gamma\) and the power density \(W\) being generated or lost in the plasma due to interaction with the laser. For this function, \(W\), the solution of the Maxwellian equations for the inhomogeneous plasma corona and for the range of the evanescent wave has to be calculated from the actual density and temperature profile of the moving plasma. The boundary conditions determine the input laser energy from the intensity of the incident radiation in vacuo using an intensity \(I_0\) or the amplitude of the electric field \(E_0\) for the incident radiation. The reflected radiation is found by the solution of the Maxwellian equations. One point to be considered is the values of the optical refractive index \(\gamma\), given by the plasma frequency \(\omega_p\) and the (Coulomb) collision frequency \(\nu_c\).

\[
n^2 = 1 - \frac{\omega_p^2}{\omega^2 + \nu_c^2} (1 - i \frac{\nu_c^2}{\omega^2})
\]  

(4.3)

While the electron mass involved in these quantities receives a change only under relativistic conditions, and therefore of little importance for the most applications of laser fusion, the temperature \(T\) in the collision frequency

\[
v = \frac{T^3}{2}; \quad T = T_{th} + \frac{\epsilon_{kin}}{k}
\]  

(4.4)

has to be corrected at high intensity laser radiation. The temperature \(T\) is given by the thermal part of temperature \(T_{th}\) and by the electron oscillation energy \(\epsilon_{osc}\) of the coherent motion in the radiation field given by the averaged kinetic energy of the oscillation.

\[
\epsilon_{kin} = \frac{E_v}{2e} = E_{v}^2 (16\pi n_{ec})^{-1}
\]

where \(n_{ec}\) is the critical electron density (cut-off density). Using this highly nonlinear intensity dependent temperature \(T\), the correct description of the term \(W\) of the power generation in the plasma in Eq. (4.2) will be quite complicated. Other types of nonlinear absorption have to be included.

The third equation of conservation, which completes the set of differential equations for solving the dynamic problem of the temporal development of the density \(n\), the temperature \(T\) and the velocity \(v\) of plasma within a given volume at given initial conditions, is the equation of the conservation of momentum, expressed by a force \(f\) in a plasma. This is the equation of motion

\[
f = \frac{\partial P}{\partial t} + \left( \frac{\partial v}{\partial x} \cdot v \right) + \frac{\partial P}{\partial x} - \frac{1}{4\pi} \frac{\epsilon_0}{\omega} \left( \frac{1}{c} - \frac{E \cdot E}{E^2} \right)
\]

(4.6)

The term with the gradient of the pressure, which can be called the thermokinetic force \(f_{th} = \nabla(1+Z)k T_{th}\), and the following Lorentz term are well known in plasma physics. The next nonlinear term was found by Schlutter when he derived Eq. (4.6) from the addition of Euler's equations for electrons and ions. The subsequent nonlinear terms had been derived in connection with the laser plasma interaction\(^{11}\) including the last term. This term is usually neglected in a plasma because during laser interaction, time averaged space charge neutrality has to be fulfilled, but it is possible to have oscillating space charges corresponding to the coupling of electromagnetic waves with electrostatic waves. This process is an automatic result from the complete solution of the Maxwellian equations.

For the special condition of plane waves normally incident onto a stratified plasma with a depth in the \(x\) direction (if linear polarized waves are used with \(F = E_x E_y\) and \(H = B_x H_y\)) the force density without the thermokinetic force \(f_{th}\) is the nonlinear force\(^{11}\)

\[
f_{NL} = f - f_{th} = \frac{1}{c} \frac{H}{x} = \frac{1}{\delta x} \frac{E_x^2}{16\pi} \frac{\omega^2}{\delta x [B]}
\]

(4.7)
where the last expression is the evaluation for the WKB approximation. This last expression, in contrast with the more general other expressions, is formally identical with that for the solid hydrogen, hydrogen plasma with a standing electromagnetic wave. The equation (4.7) was derived for propagating waves into a plasma with high densities, containing the low density standing wave as a special case. If one applies the expression of Eq. (4.7) for obliquely incident plane waves a contradiction arises with respect to a non-balanced momentum in the plane of the plasma surface. To overcome this problem, the additional nonlinear terms (and only these) had to be added in the equation of motion, so that the most general formulation of the nonlinear force according to the present knowledge is

\[
\frac{1}{c^2} \mathbf{j} \times \mathbf{E} + \frac{m}{4\pi} \mathbf{E} \cdot \mathbf{E} - \frac{1}{4\pi} \mathbf{E} \cdot \mathbf{E} (1 - \mathbf{n}^2)
\]

It should be remarked that the expression "nonlinear force" takes into account that the force (4.8) contains two types of expressions one of which can be called "ponderomotive force", but the other additional terms which appear depend on the collision frequency and therefore on thermal plasma properties. A general derivation of an additional "Stamper term" was given recently.

The predominance of the nonlinear force over the thermokinetic force was shown to be restricted for laser intensities above a threshold `I`, which is between \(10^{14}\) and \(10^{15}\) W/cm² for neodymium glass laser radiation and about 100 times less for CO₂ lasers. If plasma densities near the cut-off are considered and a very small temperature dependence is included. A very general derivation of the nonlinear force from the kinetic theory was given by Peratt

The purely thermokinetic behaviour of plasma at laser irradiation can be studied with the three equations of conservation of momentum and energy, and the three hydrodynamic equations of motion, which were given by Mulder \(1\). Rehm \(2\), and Birkhoff \(3\). A more realistic approach is given by the hydrodynamic model of plasma behaviour. Using neodymium glass laser radiation of an intensity \(10^{12}\) W/cm², incident on a solid hydrogen target, the problems of ionization and Saha equilibrium could be neglected. The developing plasma corona absorbed the laser radiation up to the cut-off density, and the plasma was moving to the interior causing a compression of the plasma there. Though the cut-off density was much lower than that of the solid hydrogen, hydrogen plasma of more than four times the solid state density was produced by the ablation process. It has to be noted that this process of compression of the plasma interior was the automatic result of the computation. A similarity to a shock process is not fully correct, a rakine-hugoniot model has one undefined parameter and result in very thin shocked layers, whereas the results of the fully complete hydrodynamic calculations show relatively thick layers of compressed plasma.

The incident laser radiation exceeded \(1\) significantly, e.g. using \(10^{16}\) W/cm² neodymium glass laser radiation, Shearer, Kidder, and Zink \(4\) demonstrated a very unexpected result based on the nonlinear force \(5\). The then mainly acting nonlinear force caused the generation of a density minimum near the cut-off density and a steepening up of the plasma density profile in the superdense region. Such minima were later called "cavitons". These cavities have been reproduced again by several authors in connection with perpendicular incidence \(6\) as well as in other geometries \(7\). Their experimental observation was first due to Marci \(8\) for laser irradiated plasmas and simultaneously for microwave irradiated plasmas \(9\). The experiments for laser plasmas demonstrated in all details the generation of nonlinear force produced cavities \(10\).

5. COLD BLOCK MOTION AND FAST SOLITON DECAY

The very complex properties of the nonlinear processes at laser interaction can be seen from fully hydrodynamic calculations using an equation of continuity, an equation of energy (including nonlinear optical constants in solving the Maxwellian equations) and an equation of motion of the kind of (4.8). Take a plane electromagnetic (Nd glass laser) wave perpendicularly incident on a stratified plasma (of which the inhomogeneous initial density is chosen for \(x = 50\) and \(50\) as a bi-Rayleigh profile \(11\) with a maximum near the cut-off density at \(x = 0\)), the output of the electromagnetic energy density \(E^2 + H^2\) and of the plasma velocity for a laser intensity of \(10^{16}\) W/cm² is given in figures 1 and 2. At 1.5 psec, plasma velocities of \(10^7\) cm/sec and more have been reached. A thick block of compressing plasma with a low temperature close to its initial value has been produced between \(x = 0\) and \(40\).

At 2.5 psec, the earlier smooth \(E^2 + H^2\) profile is oscillating, causing oscillations of the velocity and density, sharp reflection preventing laser radiation penetration below \(x = 30\). The velocity oscillations in the corona \(x > 30\) causes a very fast thermalization within few psec of the whole corona giving genuine temperatures of \(> 10\) keV. This fast heating by nonlinear forces can be described as a soliton decay. Studying a series of outputs \(1\) of the kind of figures 1 and 2, R. Godfrey \(12\) plotted "velocity" - solitons (in contrast to acoustic or Langmuir solitons), by finding a numerical correlation of \(\delta (E^2 + H^2)/\delta x\) and \(\delta^2 V/\delta x^2\) for which \(2\) an appropriate dispersion function \(\mu\) in the following Korteweg-de Vries equation was established:

\[
\frac{1}{8m\mu_i} \frac{\partial}{\partial x} (E^2 + H^2) = -\mu \frac{\partial^2 V}{\partial x^2}
\]

The first identity corresponds to the equation of motion (4.7) or (4.8) where \(-\mu\) or the sake of correlation - the thermokinetic force had to be dropped. The dispersion function \(2\)

\[
\mu = \frac{1}{1 - n_e/n_{ic}} \frac{\partial}{\partial x} (1 - n_e/n_{ic}) = \frac{\partial}{\partial x} \ln (Re \mathbf{n}^2)
\]

is familiar from the theory of resonance absorption.

The result of the fast moving thick compressing block can be used for a nonlinear force - fast pusher compression scheme, while the later occurring fast heating of the corona by soliton decay can be used for the gas dynamic ablation-compression scheme of
J. Nuckolls\textsuperscript{19}, described in the following section.

The result of the fast soliton decay has far reaching consequences for laser plasma interaction. If the decay has been built up, strong reflection occurs and no radiation is transferred to the plasma until the fast thermalization causes a homogenization and expansion of the corona. After this, there is again a penetration of laser radiation, low reflection, block motion and finally again soliton decay in the corona with strong reflection. Therefore at $10^{16}$ W/cm$^2$ Nd glass laser intensity and above, a pulsation of reflection, soliton decay and ablation with a period of few psec for 1.06\mu wave length irradiation will happen.

To avoid this pulsation, a restriction to laser intensities below the nonlinear effects of less than $10^{14}$ W/cm$^2$ is one alternative. However, then the gap for producing the necessary high plasma compression is worse. Another difficulty is the impossibility of a thermalization by Coulomb processes\textsuperscript{23} within the desired short time for gasdynamic ablation. One way out was the hope that parametric instabilities would provide a faster thermalization. It has been shown\textsuperscript{44}, however, that these processes are quantitatively not strong enough; only 1 to 10\% of the energy transfer can go by these processes even under best conditions. The possibility of oblique incident radiation and use of resonance absorption for p-polarization\textsuperscript{44,45} could cause fast thermalization, but it caused a loss of symmetry of pellet irradiation, which is basically necessary for laser compression.

All these problems are solved, if the soliton decay is used for fast thermalization of the corona at perpendicular incidence. To avoid pulsation, a high intensity and short irradiation scheme will be the solution. The success of the short pulses\textsuperscript{46} is an encouraging indication.

6. TWO DIFFERENT COMPRESSION SCHEMES

In order to explain the differences of laser compression of plasma by nonlinear forces or by gasdynamic ablation, the following description will be given. The earlier scheme developed by Nuckolls\textsuperscript{19} and several other authors, starts from the irradiation of a spherical pellet by lasers where intensity has to increase according to a certain time dependent program, where e.g. for neodymium glass laser pulses, the intensity is slowly increasing over many orders of magnitude during the first few nanoseconds, where 50\% of the laser energy has to be deposited during the last 60 to 100 psec\textsuperscript{19}. The laser radiation generates a plasma at the pellet surface where the plasma is being expanded to the vacuum due to the high temperatures generated in the plasma corona. As a reaction, the plasma below the cut-off density (where the electron density causes a plasma frequency higher than the laser frequency) will result in a motion toward the plasma interior with a compression of plasma. It was remarkable, that this kind of compression was the immediate result of the hydrodynamic calculations, as published first by Mulser and Rehm\textsuperscript{38}. The Nuckolls\textsuperscript{19} type increase of the laser intensity causes an addition of the compression process, where finally a compressed core of ten thousand times the solid state density will be achieved\textsuperscript{19}. This result can be obtained automatically from the hydrodynamic calculation of the laser plasma interaction, where extensive computer capacity is necessary.

A similar kind of compression to very high densities can be calculated from the sequence of shock wave production in the plasma pellet by a sequence of laser pulses with increasing intensity. This process follows a model of Guderley (1941)\textsuperscript{29}, where the timing of the

![Graph showing plasma expansion calculation](image)

**Figure 1.** Fully dynamic calculation of plasma expansion at plane wave perpendicular incidence on a stratified plasma using nonlinear optical constants, nonlinear energy dissipation and nonlinear (electrodynamic) forces. An initial bi-Rayleigh density profile from −50\mu to +50\mu is assumed. Profiles of $(E^2 + H^2)/8\pi\eta$ are plotted for the times 1.5 psec and 2.5 psec of interaction.

$\alpha = 2 \times 10^4$

$I = 10^{16}$ W/cm$^2$

Temp = $10^8$ °K

$T = \ldots 1.5$ psec

$\ldots 2.5$ psec

$\lambda = 1.06$ μm
pulses, of their intensities and of the speed of propagation of the shocks to the center are scaled in such a way that the shocks are coincident in the pellet center at the same time. It has to be noted that this shock wave model describes some essential properties of the Nuckolls scheme. However, the high entropy production in a purely shock wave type process is very undesirable. The selection of the appropriate increase of the laser intensity is one of the parameters to be chosen in an optimized way for a minimum entropy production. The total efficiencies for the compression of plasma by neodymium glass laser pulses show quite low values, as e.g. only 5% of the incident laser energy can be transferred into the compressed core. These efficiencies are high enough, however, to achieve nuclear fusion gains for deuterium-tritium reactions of 40 if the incident laser energy is 200 kJ.

It seems as if the hydrodynamic properties of the compression by the gas dynamic ablation scheme of Nuckolls follow automatically from the hydrodynamic codes, but if we look into the details of the process there are several points where complications will arise. The first is the need to transfer the laser energy in the plasma corona sufficiently fast into the heating of electrons and ions to ensure their subsequent hydrodynamic motion. It has been pointed out that the usual thermalization by the Coulomb frequency is too slow. The collision time for $10^{16}$ W/cm² neodymium glass laser radiation can exceed the time of 60 psec characteristic of the main laser pulse in the Nuckolls scheme. It was therefore necessary to look for fast thermalization processes to avoid having to step back to undesirably low intensity laser interactions. As has been mentioned, the parametric decay instabilities could not provide the sufficient quantities of energy absorption necessary for the dynamic processes.

Another possibility of a fast energy transfer for oblique incidence at p-polarization is the resonance absorption. However, an asymmetry of irradiation of the pellet will occur. One way out for achieving fast thermalization in the plasma corona at very high laser intensities at symmetric (perpendicular) irradiation is the use of soliton decay in the corona due to the nonlinear force interaction, as described in connection with figure 2. These processes are fast however on the scale of laser interaction, if one takes into account that the soliton decay may occur within some psecs of interaction. Very probably, the interaction times up to nsecs for neodymium glass laser radiation will be too long.

Another problem in the Nuckolls scheme is the transport processes of the laser radiation into the interior of the plasma. There have been extensive studies about the processes of electron heat waves for oblique incidence and p-polarization. The resonance absorption should result in high energy electrons directed toward the interior of the plasma and these will support the heating of the compressed front of the plasma. These transport processes and that of the thermal conductivity in the compressed pellets (together with the absorption processes) are considered as crucial problems in the plasma corona for the Nuckolls scheme.

The alternative scheme of laser compression is that of producing a quick pusher in the plasma where the nonlinear forces could be used for a very efficient transfer of optical energy into kinetic energy of thick blocks of fast moving plasma, when the interaction process has scarcely changed the temperature of the compressed plasma. As has been shown by the example of figure 1 and 2 the generation of the fast moving compressing block is during the initial of interaction before the soliton decay begins. The fast motion of the compressing block still holds at later times, but it is obvious that no further transfer of laser radiation to increase the kinetic energy of this block is possible, since the soliton decay of the surface absorbs the irradiated laser energy before it can interact with the compression block.

The high efficiency of the transfer of the optical

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Figure 2. Velocity profiles for the same case as in Figure 1.
energy into kinetic energy of compressed plasma can be seen from earlier calculations\textsuperscript{27} where 23\% of the incident radiation was received in the compressing plasma block. The more recent calculations for interaction times of several psec\textsuperscript{28,29} resulted in the transfer of the energy of incident laser radiation into the compressing block. The subsequent motion of the compressing block can be described as an imploding spherical shell which, after collapsing, will be compressed. The kinetic energy of the plasma will then be transferred into thermal energy. If the initial conditions at the time of collapsing correspond to a Gaussian density and linear velocity profile, the conditions of the self-similarity model are fulfilled\textsuperscript{28,29} and an ideal adiabatic or isentropic compression and expansion of the spherical plasma will occur. If nuclear fusion reactions are included, a certain disturbance of the ideal adiabatic conditions will be unavoidable. Strong deviations from the ideal adiabatic conditions will result in undesired shock processes and heating which can cause decreases of the final nuclear fusion gains by up to a factor of ten\textsuperscript{30,31}. In these calculations with entropy production, however, the initial conditions have not been chosen in an optimal way, therefore an improvement is possible even for nonideal conditions of the plasma at the time of compression.

The value of the velocity of the compressing block of plasma has to be chosen in such a way that the optimized fusion temperature at maximum compression will be produced, and this is between 2 and 10 keV for DT reactions and between 30 and 100 keV for the HB\textsuperscript{13} reaction for compressions up to 10\textsuperscript{5} or up to 10\textsuperscript{6} times that of solid state densities respectively. An example of how to produce a 20 MJ DT-fusion energy by a CO\textsubscript{2} laser pulse of 400 kJ energy and 300 psec duration has been described before\textsuperscript{32}, where the problems of pulsatation have been avoided because of the longer wave length. The nonlinear force fast pusher scheme was applied. The fusion gains were calculated by a general code where fuel depletion, loss by bremsstrahlung and reheate in agreement with Nuckolls was used\textsuperscript{31}.

7. CONCLUSIONS

While the laser fusion is at present producing more genuine fusion neutrons than the tokamak with magnetic confinement, if use of short laser pulses is preferred, then improving nonlinear effects can avoid considerable complications. Nonlinear processes for the preferred geometry of perpendicular incidence can avoid the problems of resonance absorption, while parametric instabilities have no quantitative influence on the energy balance.

The early stages of interaction show the generation of thick "cold" compressing plasma blocks which can be used for a nonlinear fast pusher compression of high efficiency (low entropy production). A short time interaction results in a fast thermalization of the plasma corona by soliton decay and this provides the necessary condition for Nuckolls' gasdynamic ablation-compression. For longer duration of high intensity irradiation, a pulsatation of reflectivity and thermalization will complicate the interaction.

REFERENCES

PHYSICS AS A GENERAL EDUCATION

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A school of thought seems to have grown up of recent years to the effect that our education is (or should be) a training for employment.

I would strongly oppose this view on the ground (a) that it is an exceptional occupation that needs formal training for even the compulsory ten years of primary and secondary school education, and (b) that man is more than a bread-winner whose personality and leisure time activities are no concern of the educator.

The history of our Institutes of Technology should convince even the sceptics that the people do not want pure job-training. Education for life is more than education for employment, and should enhance man’s enjoyment of his intellectual powers, of his sport and recreation, of his inter-personal relationships, and of his political and religious milieu. Such enhancement of the quality of life may usually be expected also to bring material benefits to the individual and the community.

There are those who see the arts as fulfilling this role, but in this paper I would like to develop the theme that the sciences, and particularly physics, can do it better. Physics is not the heartless, impersonal bogey it sometimes appears. I believe it is suitable not only as a professional training, but also as a core subject for a general education. More than that, it is probably the best core subject for modern times.

A recent statement by the European Physical Society reinforces this view “A sound knowledge of physics and mathematics is the basis for an education in both the natural sciences and technology. Knowledge and understanding of the physical world are essential components of modern culture”. Physicists were urged to speak up for physics as a discipline which has had and will have a profound impact on our civilization.

There is a problem in making these insights more widely available, as the physical sciences are often held to be difficult. This is at least partly because these subjects do not fit in with modern theories of education, which place undue emphasis on learning rather than teaching. In the sciences the two are inseparable. Any tendency to reduce the amount of laboratory work (the learning process) in favour of course work of an abstract nature is therefore to be deplored, but I would emphasize that past achievements cannot be arrived at inductively — they must be taught. To see further, we must stand on the shoulders of the giants (Newton).

There is a framework of natural law within which the early history of time and matter took place, and it is fascinating that evidence is being obtained today, over incredible distances, of events which occurred many millions of years ago. Similarly, future developments must take place within the framework. The old name of Natural Philosophy is more revealing of the breadth and scope of physics.

I am told that students see physics as cold, impersonal and mechanical. Listen to Sir Cyril Hinshelwood: “Science is not the dryly syllogistic handling of obvious facts. It is an imaginative adventure of the mind seeking truth in a world of mystery”. There is one big assumption in physics — that the universe is orderly, and is capable of rational explanation by man. No one can be a scientist without that kind of faith. And many have gone further: why is the universe rational, and why does man take pleasure in its decipherment? Here we are in the realm of Religion. Kepler, while putting the final nails in the coffin of the geocentric universe, said “I am thinking God’s thoughts after Him”.

Until the early part of this century, no education was considered complete if it did not include the Classics. This background of history and philosophy passed down from ancient times was held to put man in perspective — to give him an appreciation of his place in the world, and a motivation for his activities. The discipline involved in the correct use of Latin and Ancient Greek was also held to be an effective training in both logic and memory, and it undoubtedly helped to produce writers and orators capable of polished use of their own English tongue.

We are the poorer for the emasculation and slow death of the Classics, and although I do not believe they deserve the scorn with which they are now viewed by educators, their elevation as the branch of learning which gives man the mastery of the best in the world has been an anachronism since the Industrial Revolution. I take it as axiomatic that an educated person should have at least an elementary physical understanding of himself, his world and his technology, as well as reasoning ability, creativity and curiosity. Such a person will have no difficulty in entering the world of the humanities should his interests lie in that direction; as a matter of fact he will continue his education along these lines for the rest of his life.

Education is learning to ask the right questions, and should aim at understanding rather than mental gymnastics, even though, as Wilkinson says, a bit of gymnastics is good for everybody. Only by an understanding in principle can a person avoid the superstitious “cargo cult” attitude to technology that we see in many individuals today. And only thus can we hope to avoid being gullied by the salesmen, the tradesmen, and even the newsmen and politicians who so beset him round in every day life.

My contention is that science is not necessarily a vocation or a meal-ticket; it is an outlook on life that both enriches and simplifies the days we spend on earth. Businessman or housewife, pilot or sanitary worker, we all need to use tools, appliances and ideas for living and pleasure. Even in poetry and literature, as J. L. Lowes points out in “The Road to Xanadu”, the notion that the creative imagination, especially in its highest exercise, has little or nothing to do with facts is a widely accepted falsehood. Knowledge and understanding are the foundations of the creative spirit.

One of the difficulties this scientific outlook poses to the unconverted is also pointed out by Lowes. “Most of us have a staunch conviction that to follow the evolution of a thing of beauty is to shatter its integrity and to mar its charm. But (he says) there are those of us
who cherish the invincible belief that the glory of poetry will gain, not lose, through a recognition of the fact that the imagination works its wonders through the exercise, in the main, of normal and intelligible powers. He goes on to say that this allows the emergence of a unified and ordered world from chaotic multiplicity in science and affairs and poetry alike.

Some or all, of the sciences have the following characteristics:
1. They are motivated by curiosity about natural phenomena.
2. They are fed by observation and measurement and classification.
3. Discussion and experiment (in the growing areas) leads to a body of knowledge and of theory which makes sense on an increasing number of phenomena.
4. Inductive and deductive logic are part of their fabric.
5. Methods are individualistic — as diverse as the people involved.
6. Results are independent of politics and personality, and are universally acceptable.
7. Communication of results is a pleasure and a duty.

Training in these areas applies to most aspects of life, and a scientist, although impatient with wordiness, can usually see the essential points of arguments in other topics.

An essential difference between the sciences and the liberal arts is that such subjects as history, philosophy, politics are in a sense relative. The significance of events, personalities and actions, is subject to interpretation. Even if consensus is reached by discussion, there is seldom an opportunity to test this understanding unambiguously, or to apply or extend it even to related fields. This is the reason that the average person distrusts generalisations, and it may be one of the reasons that he finds the physical sciences difficult.

To the scientist, generalisations are meat and drink — he calls them theories or laws. They are the basis of his world view, the essence of its simplification. I have never been able to understand the almost vehement denunciation of generalisation by those who use the techniques of association of ideas as a learning aid.

It is difficult to single out one of the natural sciences over against another as a general, life-enrichment subject; all have a place. For those mathematically inclined one would tend to suggest physics or chemistry, and for those otherwise endowed, geology or a biological science. To my mind, physics and chemistry are more all-embracing, as they must frequently be used in elucidating geological and life processes. There is considerable overlap in the fields of physics and chemistry, but even here, the explanations of chemical properties and processes are basically physical. In the ultimate, physics is not only the key to other sciences, but is also applicable to some of the fundamental driving forces which govern life, evolution, and the processes of cosmogony. Even economic theory is now coming to terms with the second law of thermodynamics.

In commenting on a Conference on Physics Careers, Employment and Education held at Pennsylvania State University in 1977, Martin Perl pointed out that the vast majority of students who take graduate degrees in physics, and many students who take undergraduate degrees would like to use physics in their career. They are probably thinking of physics as a profession, but I believe we should broaden this outlook so that the use of philosophy and techniques of physics in any sphere is a legitimate application of the training. According to the Scientific-Technical Field classification criteria, whether such a person may be classified as a physicist depends on his own assessment of his profession.

As Professor Sir Denis Wilkinson (a nuclear physicist) has said “You do not go from university to industry and there apply the knowledge and techniques brought from your first degree; you bring your familiarity with the kinds of way nature operates, and you are then receptive to the factors coming into play”. Even if we are fortunate enough to obtain physics-related employment, most of us find ourselves in areas only remotely related to what we conceive to be our professional interests (are we all, like Franchi, attracted by the intellectual approach to a theory of nature?) We have a choice of changing our interest to suit our employment, or of using the financial security of our position as a basis for achieving our own conceived goals. This choice may be more imaginary than real; I cannot believe that Einstein was entirely uninterested in the patents that provided his bread and butter.

At the 1977 Conference, T. E. Senator suggested that the main point a student should take away (from the Conference) is to be flexible. Students should not feel that non-traditional careers are second class, and more importantly the physics community should not give the impression that a non-traditional career is followed only by those who can’t measure up to the standards necessary for a traditional career.

The decisions we make daily on an individual, local, national and international scale, whether in business, economics or politics are more and more dependent on a realistic assessment of what is physically possible, on an understanding of probable consequences, and on an informed weighing of evidence. These are part of a training in physics. A training in physics is a training for life.

* A person is a physicist if he satisfies two of the following three criteria:
1. Employment in physics or a related field.
2. At least a bachelor’s degree in physics or a related field.
3. Self-identification as a physicist.
Twinkling Radio Waves

A Department of Defence team is at present studying twinkling radio waves. This twinkling or scintillation is due to the presence of ionospheric irregularities. A research team is working with the US Air Force Avionics Laboratory to try and find out how the radio wave twinkling is affected by geography, time of day and season of the year. The scientists are measuring the effects of the equatorial ionosphere on satellite to ground communications.

The measurements are being taken at the US National Weather service station in Majuro Island in the Pacific and are part of a world-wide study.

Ultimately the data will be used to predict communications reliability of UHF satellite communication systems and in developing special modulation techniques to combat the effects of scintillation. [Engineers Australia, May 18, 1979].

Unemployment Among Qualified Scientists and Engineers in Australia

An interesting paper in Search Vol. 10, No. 6, June 1969, by Stuart MacDonald of the Department of Economics, University of Queensland, questions the conventional wisdom that “during periods of unemployment those with qualifications in such ‘useful’ fields as science and engineering must inevitably be more readily employable than those with qualifications in other fields.

An examination of statistics which have recently become available seem to confirm the fallacy of the above assumption which has been the subject of earlier comment by the University of Melbourne Appointments Board Annual Report in 1977.

The paper concludes that during periods of high unemployment professional qualifications may lead to inflexibility in the type of work and sector of employment sought with a corresponding reduction in the prospects of employment.

Australian Universities to the Year 2000

In his keynote paper to the Conference of University Governing Bodies Professor Williams said that in all countries there had been a tendency for Parliaments to respond to larger grants for universities by demanding that they be more accountable — this was both understandable and potentially dangerous. The effectiveness of the concern of universities for reason, for the adventure of ideas, for the search of truth depended on a substantial measure of autonomy.

‘It is not only the persistent calls for inappropriate forms of accountability that will place a greater and more difficult burden on the governing bodies of universities. The prospective small growth in the number of students and staff will make it much more difficult than in the past thirty years to change curricula, to introduce new subjects, to recruit the brightest young scholars and researchers of each generation — at a time when it is reasonable to expect that knowledge will expand rapidly and that in the process many established theories will be disestablished,” Professor Williams said.

“It will be a formidable undertaking to improve the quality of universities during the next twenty years. Finance is an essential instrument of policy and there is a need to increase it. Councils and academic boards will need to give a more concentrated and specific attention to objectives, to the essential features of university autonomy and academic freedom, and to ways of making best use of available resources. And Councils would be well advised to give more attention to keeping the community and their elected representatives in Parliament informed of the nature of their stewardship”. [ANU Reporter]

AAEC Nuclear News

Brief periodic reports to the public and to industry from the Australian Atomic Energy Commission.

Nuclear News is produced by the Research Establishment of the Australian Atomic Energy Commission.

Technical enquiries should be sent to the Director, AAEC Research Establishment, Private Mail Bag, Sutherland, NSW, 2232. Phone (02) 531-0111. All other enquiries should be sent to the Director, Public Relations, AAEC, 45 Beach Street, Coogee, NSW, 2034. Phone (02) 665-1221.

Primary Radiation Standard

The AAEC has established and maintains the primary Australian standard for absorbed radiation dose.

Standards are a necessary part of life. On the material side we have standard lengths, weights and even beer glasses. There also has to be a standard of radiation dose. This is important in controlling radiation treatment of cancer, and in other applications of nuclear technology.

People are concerned mainly with radiation dose absorbed in the human body which is best simulated by an amount of water. But it is possible to measure radiation dose much more accurately in carbon than in water, and carbon simulates body tissue fairly well. Therefore carbon is selected, in line with overseas practice, as the best available material in which to maintain a primary standard of absorbed dose. (An experiment may be performed to relate dose in water to dose in carbon).

Absorbed dose is measured in terms of the unit called the gray (Gy) which is the dose absorbed when ionising radiation imparts energy of one joule to one kilogram of matter.

At the AAEC Research Establishment, Don Urquhart, Phil Johnson and Wayne Badger make absorbed dose determinations within a prescribed accuracy of 0.3%
for dose rates down to 1 milligray per second. The long-term variation in dose determination over 12 months is no greater than the short-term variation observed in a day’s measurements.

A detailed technical account of the Australian standard of radiation dose is given in AAEc report E455.
(The CSIRO has overall responsibility for Australian standards of measurement. In this case it has authorised the AAEc to act as its agent.)

[AAEC Nuclear News, June 1979]

Listening for Creaks

Engineers who test pipelines, bridges, underground excavations and other structures have used an AAEC acoustic emission service, operating from a mobile testing laboratory since 1976.

Altogether fourteen tests have been successfully completed. Four more are in progress and a further nineteen are planned.

When a material is stressed beyond the yield point, where it will not return to its original shape when the stress is removed, it often emits a sound; for example the creaking of timber. This sound may be pitched outside the range of human hearing and is generally called “acoustic emission” or “stress wave emission”. Brian Wood of the AAEC Research Establishment monitors these emissions with the aim of finding their point of origin which is the weakest point of the structure under test.

In a typical test, this is done using a “flaw location computer”. This is a device which estimates the position of the source of an acoustic emission, by correlating signal bursts arriving at detectors placed on the surface of the structure. [AAEC Nuclear News, June 1979]

Reactor Safety and Public Information

An information paper on Nuclear Reactor Safety for non-specialists has recently been published by the AAEC.

It is a review of a very much larger United States report on this subject known as the Rasmussen report. The review was written by Phil Gilbert, an engineer at the AAEC Research Establishment whose special study is engineering systems analysis. Mr. Gilbert gives a brief clear description of how the results of the Rasmussen reports were obtained and he assesses its conclusions and the views of the critics.

The recent accident near Harrisburg, Pennsylvania, will provide additional information on possible accident sequences in nuclear reactors and elsewhere; but it is unlikely to affect the methodology of the Rasmussen report.

The information paper [AAEC/IP14] was produced in the course of an ongoing study of nuclear reactor safety. It is one of a series of information papers written for non-specialists on various aspects of the uranium industry. [AAEC Nuclear News, June 1979]

WA Considers Two Nuclear Sites

The WA Government’s controversial decision to go nuclear by 1995 has taken a major step forward with the selection of two possible sites for a 600MW to 800MW power station.

The sites are Wilbinga and Breton Bay, about 70km and 90km north of Perth respectively.

The Government is convinced that nuclear power is a must for the State and has included it as a major item in its recently published energy policy.

The nuclear segment of the policy covers these three points:

- Consistent with the Government’s stated policy on nuclear matters, it will ensure that the State remains abreast of developments in nuclear generation and associated matters and that planning proceeds to allow decisions to be made in the requirements for nuclear power in the future.
- Having due regard to the need for appropriate health and environmental safeguards and prudent practices, the Government will encourage the mining and processing of nuclear materials in WA and the enrichment of uranium to a level suitable for use in nuclear power stations.
- Planning and siting studies will be carried out so that WA can proceed to the installation of a nuclear power station by 1995. [Engineers Australia, July 13, 1979]

‘Basic’ or ‘Attitudes’

Teaching young science students the basic content of science is more important than fostering favourable attitudes in the subject, according to a survey of WA high school science teachers.

The survey involved 188 science teachers in government and private high schools throughout the State. Renato Schibeci, a science teacher by training and Lecturer in Education at Murdoch University, conducted the survey.

“Teachers reported that they made no deliberate, systematic attempts to teach either attitudes to science or scientific attitudes,” Mr Schibeci said. Attitudes to science include interest, enjoyment and satisfaction in the study of science; scientific attitudes include inclinations such as the ‘attitude of enquiry’, ‘a willingness to suspend judgement and consider new evidence’, and ‘a tolerance of the views of others’.

Behaviour “While no specific attempts were made to teach attitudes to science, teachers felt that they could gauge accurately what students’ attitudes were,” he said.

“They regarded students who behaved badly in the class as those who had a poor attitude to science.”

It was interesting that it was regarded as ‘unrealistic’ to expect lower ability students to develop scientific attitudes. On the other hand, it was not possible to spend time developing these attitudes in the more able students because of constraints such as moderating examinations, the need to prepare students for the final two years of high school and the lack of coherence in
Industrial Research and Development in Australia

Report from the Standing Committee on Science and the Environment

Conclusions: Among the Senate Committee reports sixty-one conclusions are:

It is vital that national policies for science and technology be developed as a matter of urgency to help reverse the decline in R&D.

If Australia is to develop as an industrial nation then a change is needed which will place a greater emphasis on supporting IR&D in its own right not in subservience to, or consequent upon, basic scientific research, but in parallel with it. At the same time deliberate policies are required which will encourage and foster the flow of knowledge between science and technology.

Interaction of defence R&D and industry has been and is, with a few exceptions, poor, with industry participation in projects often invited disadvantageously late.

Perhaps the most obvious area in which the Government has failed to show confidence in the abilities of industry, is in its own purchasing and marketing policies.

The lack of suitable measures to implement past scientific and technological advances is a contributory cause of the current difficult situation of manufacturing industry.

If Australian manufacturing industry is to move successfully into the coming decade, or even survive it, the barriers preventing it from engaging in R&D must be identified. Only then can solutions be put forward and tested.

Markets, taxation and protection considerations conspire to produce a climate which is not conducive to industry conducting its own research.

Australia has been inhibited in taking a bold approach to innovation. As a result, promising technology has been left to languish undeveloped or has been exploited overseas to our detriment.

The needs and aims of society, including industry, requires universities to become involved in interdisciplinary problem-oriented research, with university courses related to real rather than abstract problems.

Because of the scale of university funding, whole areas of science and engineering, including some which are of great importance to the Australian economy, are hardly touched in Australian universities.

CSIRO as well as other Government research organisations could be more active in ensuring their work is brought to a practical economic end through increased and closer participation with industry.

Patents are treated as having minor importance in Australia. However, if Australia is to progress as a manufacturing nation it is essential that indigenous invention be fostered.

Low levels of R&D incentive grants lead to a flitting away of public money without having any appreciable effect on the quality of the nation’s technology.

Government incentives for IR&D are nowhere near commensurate with the need, nor do they bear any other than incidental relation to national objectives.

R&D projects should be selected for support with a clear idea of their relation to national policies and their likely effect on industrial progress and economic growth.

[Engineers Australia, June 29, 1979]

Prizes

HOLWECK MEDAL AND PRIZES

The Council of The Institute of Physics announces the award of the 1979 Holweck Medal and Prize to Professor A. Blandin of the Universite Paris-Sud, Orsay, for his outstanding contributions to the theory of metals.

HEWLETT-PACKARD EUROPHYSICS PRIZE

1979 AWARD

The 1979 prize as announced last month has been awarded to Eric A. Ash of London, Jeffrey H. Collins of Edinburgh, Yuri V. Gulaev of Moscow, Kjell A. Ingebretsen of Troedheim, Edward G.S. Paige of Oxford.

All made important contributions to our understanding of the interaction between surface acoustic waves and electrons, and to the development of new devices based on this knowledge.

Presentation of the award, which is worth 20 000 Sw. Fr., will be made at the opening of the EPS Conference on the Physics of Semiconductor Surfaces and Interfaces to be held in Paris, 26-28 November, 1979.

[Europhysics News, June 1979]

MAX BORN MEDAL AND PRIZE

The Institute of Physics, London, and the German Physical Society announce the award of the 1979 Max Born Medal and Prize to Dr J. B. Taylor of the Culham Laboratory, UKAEA, for his work on the theory of plasmas particularly in relation to controlled nuclear fusion.

The presentation will take place in September 1979 during the annual meeting of the German Physical Society in Ulm.
CONFERENCES AND EXHIBITIONS

The 17th General Assembly of the International Union of Geodesy and Geophysics. Canberra on 2-15 December 1979. Details are available from the Executive Director, Organising Committee, IUGG 1979, Australian Academy of Science, P.O. Box 783, Canberra City, ACT 2601.

This is a major event in the international geophysical community and occurs once every four years. The fact that this time it is in Australia gives particular opportunity to local geophysicists.

Joint Symposium Physiological Measurement
Australian Sports Medicine Federation (Qld. Branch)
Society of Medical and Biological Engineering (Qld.)

Fourth Australian National Conference and School on X-ray Analysis, with sessions on Surface Analysis.
Australian National University, Canberra, 4th-8th February, 1980, sponsored by the Australian X-ray Analytical Association.
Papers (20 min) and Posters to be presented at the Conference Sessions are now invited. A copy of the Title(s) should be submitted by 31st August 1979.
All enquiries and copies of abstracts should be addressed to the Conference Secretary: Miss D. Oliver, AXAA National Headquarters, C/- NSW Institute of Technology, PO Box 123 Broadway, NSW 2007. Telephone (02) 20 930 Ext 9402.

Liquified Natural Gas
6th International Conference and Exhibition, Kyoto, Japan, April 6-11, 1980. Information: Institute of Gas Technology, 3424 South State St., Chicago, III. 60616, USA.

17th Annual Solid State Physics Conference
The 17th Annual Solid State Physics Conference, organized by the Solid State Physics Sub-Committee of the Institute of Physics will be held at the University of Warwick, Coventry, from 14 30h on Wednesday, 2 January to 18 00h on Friday 4 January, 1980.

EMAG '79
EMAG '79, organized by the Electron Microscopy Group of The Institute of Physics will be held at the University of Sussex, Brighton, from 3-6 September 1979. Further details and registration forms for the Conference are available from the Meetings Officer, The Institute of Physics, 47 Belgrave Square, London SW1X 8QX.

Autumn Conference of Institute of Acoustics
Windemere, 4-6 November, 1979. Information: Dr R. Lawrence, Acoustics Group, Liverpool Polytechnic, Byton St., Liverpool 3.

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Radiation Protection
Jerusalem, Israel, March 9-14, 1980. Information: Dr Tavia Schlesinger, Soreq Nuclear Research Institute, Yavneh 70600, Israel.

Plasma Physics
April 7-11, 1980, Tokyo. Information: K. Tagayama, Institute of Plasma Physics, Nagoya University, Nagoya, Japan.

AIP FOURTH CONGRESS
25th—29th AUGUST, 1980
AT THE UNIVERSITY OF MELBOURNE

Secretary Dr. R. J. Fleming
Physics Department
Monash University
A residential Solid State Physics Meeting will be held on Pakatoa Island, near Auckland, New Zealand, from Tuesday 22 January to Thursday 24 January, 1980. The meeting is sponsored by the New Zealand and Australian Institutes of Physics.

General

This is an opportunity for physicists with interests in any aspect of solid state physics to get together in the informal atmosphere of a tourist resort to discuss their research work and facilities.

The meeting will include:

(a) invited review papers on selected subjects,
(b) contributed papers and research reports.

The meeting will cover a wide range of topics including magnetic, thermal, transport, resonance, optical, mechanical and structural properties of solids.

Contributed papers may cover completed work, progress reports on incomplete or controversial topics, or even "cries for help". There will be no parallel sessions. Invited review papers will be presented as lectures, while contributed papers will be shared between poster sessions and oral presentation. As in past meetings, posters will be on display for 24 hours.

Dates and Times

Indication of intention to attend to be returned by 15 August 1979
Application forms will be distributed in October
Applications to attend close on November 1, 1979 (late applications may be accepted subject to availability of accommodation)
Abstracts of contributed papers must be submitted by December 21, 1979
Conference Sessions start at 9 am Tuesday 22 January 1980
Conference ends at mid-day Thursday 24 January 1980

Costs

The cost for participants (including accommodation, meals, tea and coffee) will be approximately NZ$70 (A$65) for the full conference period. Travel from Auckland airport to Pakatoa return is approximately $10.

Student members of the Australian Institute of Physics may apply in advance to the Hon. Secretary of their local branch for financial assistance to attend the meeting. Assistance for New Zealand Students is available through the NZIP (contact Dr. C. Cook, Victoria University of Wellington).

Conference Fee

There will be a conference fee of $5 for Institute of Physics members and $10 for non-members.

Information and Application Forms

Application forms will be sent to institutions that have been represented at previous Wagga meetings. Further information and application forms may be obtained from Prof. D. Beaglehole, Physics Department, Victoria University of Wellington, New Zealand, or the Australian coordinators: Prof. T.F. Smith, Monash University, Melbourne; Dr. D. Price, ANU, Canberra; Dr. J. Dunlop, NML, Sydney.