The Australian Physicist

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NOTICE
SCHOOL OF PHYSICS
Seminar - Experimental Physics

 'The Theory of Sealing Wax and String'

Papers yet to be given
President's Column

In my first President's column, which I shall continue during my term in office, I would like to pay tribute to the direction in which James Campbell took the Institute during his Presidency. As we develop a better educated society there is more questioning of the opinions of experts, and an increasing realisation that the public should make decisions on technological matters which affect its members. This is particularly evident in the current nuclear debate.

To this end the Institute has set up its Science Policy Committee, which has the responsibility to supply accurate and unbiased information on the physics of major proposals. Results of the work of this committee, which was chaired by James will become evident in the next two years.

Other committees of Council have been set up to deal with education and employment. These, and the Science Policy Committee are self nominating and I urge members of the Institute to write to the secretary if they are interested in contributing to their work.

Letter

SIR,

I read J. P. Lonergan's letter in the December issue with great interest.

In these days of extended management expertise in the area of science where we have so many of our most highly trained scientific personnel lending cognizance to the important and once neglected areas of management science and social awareness, one can well understand the frustrations suffered by Mr. Lonergan. Dysfunctional decision making processes, thank God, are becoming a thing of the past.

However, I, for one, firmly believe in, in fact am firmly committed to, CENTRALISED INTEGRATION of management services! In this way, and only in this way, can we facilitate the smooth two way flow of interim decisions and so gain meaningful worker participation. By this means we can ensure that the workers at the coal face can be appropriately briefed and de-briefed at all times, thus opening up channels of communication for the maximum deployment of available resources in a way that is not only cost effective but can be seen to be cost effective.

Perhaps Mr. Lonergan and his colleagues could address themselves to this important area of modern scientific administration. Such a scenario would provide a bench-mark of inestimable value, adding considerable weight to the credibility and relevance of science policy making as a whole.

Yours truly,
D. S. Robertson, FAIP.

Obituary

BILL DURANT

His many friends will be sorry to hear of the death of Mr. Bill Durant, Head of the Physics Department at Ballarat C.A.E.

His death occurred suddenly at Armidale on Wednesday 19 January 1977. At a memorial service at Wesley Church, Ballarat, a large number of his friends, colleagues and former students assembled. It is hoped to publish an appreciation later. His friend and colleagues in the Australian Institute of Physics extend their sympath to his widow and daughter.

H.C. Bolton
CSIRO Enquiry

While this submission of the AIP is made by the Council of the AIP it does not commit individual members of the AIP to statements and conclusions published in this report.

PREAMBLE

This submission by the AIP is basically in support of the excellent record of CSIRO in scientific research with some suggestions for extensions to its interaction with other bodies.

TERM OF REFERENCE 1 — the objectives of the Organization and the relevance to the present and future requirements of Australia of its functions as set out in the Science and Industry Research Act (1949).

Ever since its inception the CSIRO has acted as a source of research results in Australia. From the beginning of the '39-45 war its research expanded into many new areas involving secondary industries and examples of what we as physicists see as some of its strong areas are Radio Astronomy, Chemical Physics, Tribophysics, Measurements and Standards, Textile Physics and Atmospheric and Environmental Physics. The Committee of Inquiry will scarcely want us to detail the many international reputations gained in these areas; there are many CSIRO physicists who are Fellows of the Australian Academy of Science, Fellows of the Royal Society of London and who have won international medals and awards. In our view these successes have arisen by a welcome blend of pure and applied research. In so far as CSIRO's effectiveness in serving the community be maintained, it is essential that it preserves the highest level of scientific competence. We believe that this requires a component of pure research to be present together with applied research. We believe the dictum usually ascribed to Sir David Rivett namely “Get the best man for the job and then give him his head”. We support the way in which this policy has been used in the past to establish the CSIRO as a model of success.

The Science and Industry Research Act (1949) states in section 9(1); “These powers and functions of the organization shall, subject to the regulations and to the approval of the Minister, be
(a) the initiation and carrying out of scientific researches and investigations in connection with, or for the promotion of, primary or secondary industries in the Commonwealth...”.

The AIP believes that this should be amended to include new community needs which have arisen in areas such as the environment, social problems and nutritional science. A suitable phrase (underlined) could be “The initiation and carrying out of scientific researches and investigations in connection with, or for the promotion of, primary or secondary industries and other research activities that may be judged necessary to meet community needs in the Commonwealth...”, even though this point is apparently covered since the Act allows consideration of any matter referred to the CSIRO by the Minister.

TERM OF REFERENCE 2 — the extent to which the current research program objectives and the emphases given them accord with the objectives recommended for the Organisation.

The AIP had available to it the CSIRO document “Research Program Objectives 1976” which it found a clear and valuable statement of scientific objectives which are moving in accord with changing emphases in what are generally agreed to be, in the broad, national goals.

TERM OF REFERENCE 3(i) — existing arrangements and procedures for meeting recommended objectives and discharging recommended functions, with particular emphasis on:
(i) the size and diversity of the Organisation, its organisational and management structure, policies for the employment of staff, and the role of consultative and advisory machinery.

The AIP believes that one of the real strengths of CSIRO is that promotion is on scientific merit and that scientists do not have to become administrators to rise to the top of their profession. In a recent AIP survey of the employment of physicists, respondents from the CSIRO indicated that on average 80% of their time is available for scientific work. This is to be compared with 50% in replies from respondents from other Government laboratories. The CSIRO has a reputation for being independent of what we may, without prejudice, call public service attitudes and the AIP hopes that nothing will be done to undermine this independence. For instance, any suggestion of moving Divisions away from CSIRO seems to us fraught with possible dangers.

The AIP believes that large scale reviews of the aims and programs of all scientific laboratories and organizations are valuable. These reviews may be made at regular or irregular intervals and may coincident with changes of Chiefs of Division or other management restructuring. It is emphasized that such reviews should include external advisers with expertise in scientific, technical and applications areas. The results of such reviews should be in the form of advice to CSIRO management. For example, a Chief of Division would be able to use as much of the advice as he judged to be beneficial for his Division’s program.

TERM OF REFERENCE 3(ii) — (ii) the relationship of the Organisation with Government agencies, industry, tertiary institutions, research institutes, and with users of research results.

Much good has arisen in the past from the close geographical association of CSIRO Divisions with universities or other laboratories. We quote as examples of such associations Tribophysics on the Melbourne University campus, Chemical Physics next door to the Monash University campus; we would like to see more
chemical divisions moved to the Clayton site of CSIRO. We regret the need for the impending move of the National Measurement Laboratory away from Sydney University. The AIP wishes to emphasize that, in spite of difficulties, CSIRO should do more to stimulate interaction between Government agencies, industry, tertiary institutions, research institutions and users of research results.

As examples, we make the following two suggestions. (a) In the area of CSIRO—University collaboration the question of training younger students and research workers has long been debated. The Science and Industry Act (1949) states in 9(1) that "The powers and functions of the organization shall ... be:

(b) the training of scientific research workers and the establishment of scientific research studentships and fellowships".

In the spirit of this section we know that CSIRO has for long awarded post-graduate scholarships and post-doctoral fellowships. We applaud this. Post-graduate scholarships are now awarded in large but insufficient numbers both by the Commonwealth Government and by individual universities and we urge that they continue. We are firmly of the opinion also that the post-doctoral fellowships have their place in our scientific life.

We would also like to urge that the spirit of the first part of Section 9(1)(b) be fostered. We believe that every encouragement should be given to the use of CSIRO officers not only in training of higher degree students but even of undergraduates. We know of some universities that have invited CSIRO officers to give undergraduate courses and of others that have seconded their research students to work in CSIRO laboratories. We encourage the Committee of Inquiry to lend its support to the general concept of collaboration in this field of training younger people. Australia does not have a large number of scientific workers; we should employ the talents of all. We note that this was essentially one of the recommendations in the CSIRO Advisory Council 1967 Report of the Committee on Relationship between CSIRO and the Universities. (b) Whilst members of the CSIRO are always prominent at scientific meetings, we feel that the CSIRO could take new initiatives in the organization of opportunities for communication between the many bodies set out above. This should include forums such as those organized by the Australian Academy of Science in inter-disciplinary areas of particular relevance to CSIRO work. We emphasize should be given to interaction with public interest groups and community organizations who are becoming much more involved in decision-making on scientific and technological policies.

TERM OF REFERENCE 3 (iii) — (iii) the methods for selecting, reviewing, reporting on, and re-ordering research programs, including the effect of the differing sources of funds.

We can see dangers if particular CSIRO Divisions become dependent to a large extent on funds from industry which can be withdrawn or dwindle at relatively short notice. This can have a serious effect both on staffing and on the quality of research. There are a number of management procedures that can guard against such difficulties.

TERM OF REFERENCE 3 (iv) — (iv) the assessment of results achieved in the light of resources employed.

Detailed cost benefit analyses can be useful to management but they should not dominate policy decisions. In some development programs it is possible to make reasonable advance estimates of the economic consequences of success and other expected benefits. However, many projects may, in the long term or in indirect ways, be of immense benefit to the community but this is not always predictable. The AIP regrets strongly the current tendency to live on scientific capital without investing in scientific developments which will be vital in the future. Our proposal for assessment of results is contained in our response to 3(i) above.

TERM OF REFERENCE 3 (v) — (v) the processes involved in the implementation of research results.

In the allocation of Australian Industries Research and Development Grants, preference should be given to the support of development work arising from Australian research in CSIRO or other laboratories. The AIP welcomes the support that has been given to Interscan and urges that more attention be given to the problems of funding for the phase of development of Australian ideas between scientific demonstration and commercial adoption.

TERM OF REFERENCE 3 (vi) — (vi) the role of the Organisation in Australia's international scientific relationships.

All scientific institutions in Australia have some role to play in international scientific relationships. We hope for continuance of Government support of international conferences. The need for these is acute in Australia due to our geographical remoteness. We recognize that CSIRO may not be able to help in this area.

TERM OF REFERENCE 4 — the extent to which and the means by which programs of the Organisation could attract revenue both to support the conduct of ongoing or intended research and also in return for results achieved in research.

As pointed out under Term of reference (3 (iv)) individual CSIRO programs should not become unduly dependent on external revenue. We would oppose any suggestion that working by contract should dominate CSIRO activities. Such revenue as is attracted from the successful application of CSIRO results should be used as general funds for the Organization, but success in earning revenues should not be the sole determining factor for research programs.
Self Paced Instruction in General Physics
J.C.I. Cornish & P.J. Jennings,
School of Mathematical and Physical Sciences, Murdoch University, W.A.

This article describes the experiences we have had over the past two years with self-paced learning in undergraduate general physics at Murdoch. The term "self-paced learning" is used in this article to describe a style of teaching derived from the Keller plan but differing from it in a number of significant aspects.

1. The Keller Plan
The principles and methods of the Keller plan were first described by Keller in 1968. Since then it has been adapted to many different undergraduate physics courses. Some of the users have modified the method to suit local conditions and constraints. However most applications have the following features in common:
(a) the course content is divided into a large number of topics (or units)
(b) a study guide for each topic is prepared, containing references to textbooks, specific learning objectives, general aims of the unit, questions, numerical exercises and experiments to perform
(c) students work through the units at their own pace
(d) progression from one unit to the next is on the basis of mastery as demonstrated by satisfactory performance in some form of test
(e) lectures and demonstrations are rarely used in the course
(f) tutors provide assistance to students on an individual basis
(g) assessment is based on the number of units mastered and/or a final examination.

2. Reasons for using SPL
In planning the undergraduate Physics courses at Murdoch we decided to utilize self-paced learning for the following reasons:
(a) A wide variety of student backgrounds in Physics was anticipated. Murdoch has a flexible admission policy which allows students without formal academic prerequisites to undertake tertiary studies if they have shown promise in other relevant walks of life. Self- pacing allows students with poor preparation to spend more time on basic material which may be quite familiar to many school leavers.
(b) Limited laboratory resources meant that we had to economize on equipment purchases. Self- pacing allowed us to spread the load on laboratory equipment and thus reduce the quantities required.
(c) Murdoch provides external education in Physics and it was our goal to develop a course which could also be used by external students.
(d) We believe that undergraduate Physics instruction suffers from the artificial separation of experiment and theory. We wanted to develop a course in which theory and experiment were intertwined and physical concepts were introduced through experience of the phenomena concerned.

3. SPL at Murdoch
We have now developed a three semester strand in general Physics based on self-paced learning. The details of the topics covered are given in the Table. This strand contains all of the traditional areas of general Physics at a fairly high level of mathematical sophistication. The chapter references indicate that the courses are based substantially on the textbook *Physics* by Alonso and Finn [1972].

During two years of experience with SPL we have made the following significant modifications to the Keller plan.
(a) The course material is divided into units of approximately equal length as suggested by Keller. However our units are designed to require about one week's work for an average student rather than the shorter units suggested by Keller. This modification was introduced mainly to reduce the pressure on tutors to administer frequent tests.
(b) Three to five written tests per semester are used. Assessment on each unit is by means of assignments, reports on experimental exercises and oral testing. We believe that this is a more reliable means of ensuring mastery of the material than the use of frequent tests.
(c) The written tests are cumulative, as shown in the Table, and cover material from all of the preceding units. They are intended to ensure that students integrate the material studied and hence avoid the possibility of fragmentation (which is a frequent criticism of the Keller method). A subsidiary aim of the tests is to ensure that students have individually mastered the preceding units. We do not discourage collaboration on assignments and experiments and as students have found it to be an inevitable feature of self-paced learning. If properly handled a situation in which students assist one another can be a valuable part of the learning process.
(d) The cumulative tests are all open-book and have flexible time limits. They contain several numerical problems of comparable standard to those in the assignments.
(e) In addition to occasional lectures and demonstrations we have used several short films to introduce important concepts and to provide some background pacing for the class.
(f) There is no formal separation of theory and experiment. Experiments are chosen to illustrate physical principles covered in the course and to provide experience with scientific technique. The experimental exercises cover the entire spectrum from simple demonstrations of phenomena through to sophisticated experiments involving an element of original thought and requiring a detailed report of method and results.

Experiments and problem solving may be undertaken at any time as all classes are conducted in the Physics learning centre which is used only for this course.

4. The Techniques of SPL
In addition to the basic principles described above, we have identified several key factors which we consider to be essential to the success of self-paced courses.
(a) The staff involved with the course must be enthusiastic about the method and prepared to assist students outside formal teaching hours. Staff problems were
apparently the major reason for the failure of SPL in first year Physics classes at MIT [Friedman (1976)]
(b) A room should be available at all times for students to study, discuss problems, take tests and perform experiments. This room should have a pleasant, cheerful atmosphere (unlike most Physics laboratories) and provide bench and table space, projection facilities and a small library of reference books for the course.
(c) Social relationships are important in courses of this type. Students learn better when they feel at ease with the staff and other students in the course. They should not feel reticent about asking questions of tutors or fellow students whenever they encounter significant difficulties. We promoted social contact by holding a course barbeque and an astronomy field trip during the semester.
(d) A satisfactory textbook is essential. Alonso and Finn is our primary source of information and most students have found it adequate for as much as 90% of their reading. An important aim of our general Physics course could be stated as “the development of the ability to use a good Physics textbook effectively”.

5. Results
Our assessment of the course is that it has been successful in achieving all of the aims listed in section 2. In particular it allows students with a wide range of backgrounds and different styles of learning to study similar material without boring some and confusing others. Individual tuition is available for all students and the course is assessed on a mastery basis. Students gradually develop a confidence with physical methods which enables them to tackle difficult problems and analyse physical phenomena.

As expected the self-paced course has proved economical in the use of laboratory equipment. We require only one or two sets of apparatus for a class of thirty students. External students are able to study essentially the same course as internal students using the study guides and kits of experimental apparatus.

Student responses to our questionnaire indicate that they fully appreciate the opportunity to study at their own pace. Failure rates have been low because poorly-prepared students can be given special attention in the early weeks of the semester.

Over 80% of respondents to the questionnaire expressed satisfaction (or better) with the course, while a small minority indicated that they would have preferred a more conventional format. Many students, especially those with weak backgrounds, indicated that they had spent more hours per week on their Physics course than on any other course that semester. However many of those who found the course demanding also indicated that they had found it enjoyable. It is reasonable to conclude that the price of mastery is greater effort. It is also possible that many of the weaker students would have failed or dropped out of a conventional course.

Needless to say there are some problems still to be overcome. Procrastination is common in all Keller-type courses and our tutors must keep a careful watch on student progress and provide encouragement where necessary. Students are also given a progress chart which indicates the recommended rate of progression through the units of the course. Histograms showing the distribution of numbers of students amongst units are also posted on the laboratory noticeboard from time to

The SPL approach is considerably more demanding of staff time than the conventional large-scale lecture approach and committed tutors are therefore essential to the success of the course.

The need to provide a full-time learning centre for the course could also be a problem in some institutions.

In conclusion we are satisfied with the results of SPL within the Murdoch context. We believe that it has much to offer in general Physics teaching especially where student backgrounds are varied.

We would like to thank our colleagues at Murdoch, Bruce Mainshad, John Carras, Garth Price and Marlene Read for valuable contributions to the development of these courses. The assistance of John Guirronick and Ian Dunn of the School of Physics, UNSW is also gratefully acknowledged.

References
Alonso, M., and Finn, E. J. (1972), Physics, Addison-Wesley.

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People and Institutions

New Weather Satellite Receiving Station

Australia will obtain new equipment to improve its weather forecasting system. Contracts have been awarded for the provision of a Medium Data Utilisation Station (MDUS) at the Bureau of Meteorology headquarters in Melbourne. Equipment for the station will cost about $345,000. MDUS will enable the Bureau to receive and transmit pictures from a Geostationary Meteorological Satellite (GMS) which will be launched by Japan in the middle of next year and will commence transmission early in 1978. The Japanese GMS will be one of five located at intervals around the Equator at a height of 36,000 kilometres and will be permanently positioned over West Irian. One of the main uses of pictures received from the GMS will be to improve monitoring of tropical cyclones, but the Minister of Science in releasing news of the contract commented that although the pictures received by MDUS will be primarily for Australian usage, they will also assist with the First Global Atmospheric Research Program (GARP) Global Experiment (FGGE) on weather forecasting.

FGGE is an attempt to improve weather forecasting techniques and accuracy by the use of a combined observing system including satellites, aircraft, drifting buoys, weather balloons, specially deployed ships and ground stations.

Australia was already building a ground control station for the Japanese satellite at the Orroora Valley satellite tracking station in the ACT.

US/Australia Research Projects

Co-operative Research Visits by US Scientists to Australia

Professor Myong-Ku Ahn, Indiana State University, working on diffusion in liquids with Dr R. Mills, Australian National University - commencing January 1977 and lasting for seven months.

Dr K. W. Kemper, Florida State University, working on nuclear reactions and structure studies with Dr T. Ophel, Australian National University - commencing January 1977 and lasting for seven months.

Professor G. M. Frye, Case Western Reserve University, working on high-energy astrophysics with Professor V. Hopper, University of Melbourne - commencing January 1977 and lasting for seven months.

Professor D. W. Devins, Indiana University, working on cyclotron studies of knock-out reactions with Professor B. M. Spicer, University of Melbourne - ongoing project renewed in September 1976 for twelve months.

Dr Philip A. Ianna, University of Virginia, working on astrometric studies of nearby stars from the Southern Hemisphere, with Professor O. J. Eggen of the Australian National University - ongoing project renewed for 12 months commencing January 1977.

Co-operative Research Visits by Australian Scientists to the US.

Professor R. W. Robinson, University of Newcastle, working on graphical enumeration in the physical sciences with Professor F. Harary, University of Michigan - commenced 3 December 1976 and lasting for six weeks.

Seminars

New particles seen in Cosmic Ray and Accelerator Physics (Australian organizer Professor L. S. Peak, University of Sydney), to be held in Canberra, ACT from 16 to 20 May 1977.

Award of Queen Elizabeth II Fellowships

The Minister for Science, Senator Webster has announced the award of Queen Elizabeth II Fellowships to six Australian Scientists.

The fellowships provide for two years full-time research in the physical and biological sciences and are tenable at an Australian university or approved research institution.

Awards have been made to the following scientists:

- Dr D. Y. Chan, a research fellow at Bristol University, UK, who will work on colloidal chemistry at the Australian National University.
- Dr A. J. W. Gleadow, a tutor at the University of Melbourne who will investigate fission track dating at the University of Melbourne.
- Dr R. B. Howlett, a tutor at Adelaide University who will study the representation theory of finite groups in the Department of Pure Mathematics at Sydney University.
- Dr B. E. Kemp, a post-doctoral fellow at Flinders University who will study the biochemistry of the control of cell division at Flinders University, Adelaide.
- Dr N. Nicola, a post-doctoral fellow at Brandeis University, Massachusetts, USA, who will investigate protein structure and function in relation to leghaemoglobin at the Walter and Eliza Hall Institute in Melbourne.
- Dr G. H. Pyke, an assistant professor at the University of Utah, Utah, USA, who will carry out research into foraging behaviour of nectar feeding animals at the University of Sydney.

CSIRO Division of Soils, Adelaide - Salt damp studies

Salt crystals are responsible for the decay of some of Australia's historic buildings. Bendigo's old police barracks are being affected and problems are occurring in the sandstone quadrangle of Melbourne University where 10-year old repairs are failing due to the migration of salt from affected areas to newly repaired sections. John Hutton of the Division of Soils wants to discover where the salt originates and how it migrates. It is hoped that research will lead to an effective method of salt extraction. Engineers Australia, December 3, 1976.

Scientific Cooperation between Australia and New Caledonia

Senator Webster having spent three days in Noumea visiting French scientific institutions states that research and development work in forestry and oceanography being conducted there is of great relevance and benefit to all south-western Pacific nations and cooperation between scientists in Noumea and Australia will be encouraged. Minister of Science, 20 December, 1976.

Educating Too Many Engineers?

About 3100 students will graduate at the engineering schools throughout Australia at the end of 1976. Less
than half are likely to find jobs as engineers. Is Australia producing too many new engineers? Engineers Australia put this and related questions to R. S. Davie, assistant director, Swinburne College of Technology; Professor P. T. Fink, dean of the faculty of engineering, University of NSW; J. A. Michael executive director, APEA and Sir Louis Matheson, chairman of the Interim Australian Science and Technology Council.

Briefly, and possibly not exactly, the four page article gave the following impressions: there are not too many graduates if flexible engineers are produced (e.g. Lord Casey and Party Secretary Kruschchev) and if more graduates work “near the coal-face”; there is disagreement as to the desirability of controlling the output of graduates; in some states, e.g. Victoria there are too many alternative courses with small enrolments some of which should turn their attention to technical training; there is a general feeling that the academic standards of engineering entry students are decreasing; engineering courses are not outrageously expensive compared with others; future supply and demand trends for engineers should be surveyed. *Engineers Australia, December 3, 1976.*

**Conferences and Courses**

**International Laser-Plasma Conference**

Professor Heinrich Horz, Head, Department of Theoretical Physics, University of New South Wales, was the co-director (with Professor Helmut Schwarz) of the 4th International Conference “Laser Interaction and Related Plasma Phenomena”, 8-12 November, 1976, at RPI in Troy, New York. 72 specialists from 13 countries discussed 53 papers on lasers, laser compression of plasma for nuclear fusion, and new high intensity interaction effects. Australia was represented by Professor Horz (UNSW), Dr. Luther-Davies (ANU), Dr. Tuxton (RMIT) and Dr Nicholson-Florence (UNSW) delivering 9 papers. — General highlights were 10⁷ fusion neutrons generated by two 50 Joule Nd glass laser pulses on DT microballoons from Livermore Labs., the hundred times increased neutron gains from balloons at cryocondensation (KMF-Fusion), the 216 beam laser of Basov-Skilzov (Moscow), 1 MJ 1µsec - 8% efficiency pulses from nuclear-pumped gas lasers (Miley, U Illinois), Terawatt iodine lasers (Garching), the first feasible Q-switch for gamma ray lasers (G. V. H. Wilson et al. Duntroon) and several measurements of laser produced MeV ions pioneered by the ANU-group. Based on the new relativistic self-focusing theory (UNSW), a new accelerator for 100 GeV heavy ions with the next 10¹⁸W lasers has been concluded, of 10¹⁹ higher ion densities than in accelerators, which may open a new area of high energy physics.

**Eleventh Congress of The International Commission For Optics**

Sponsor: International Commission for Optics.
Topics: (1) Vision; (2) Image analysis; (3) Optical processing; (4) Physical Optics.
Date: September 10-17, 1978.
Organisation: Spanish Committee of the International Commission for Optics.
Information: J. Becos, Sociedad Española de Optica (SEDO), Serrano, 121, Madrid 6, Spain.

**Biggest Number Contained in Print**

“752413 as a factor of A2310
where A2310=2³¹³¹⁰ +3

and A2310 is by far the largest number for which any non-trivial factor is known.”

A line drawn from our planet Earth to the furthest astronomical object known would not be nearly long enough to contain this number printed in the normal way. That is to say that a line from here to the furthest quasar recently discovered by Australian scientists would not contain it.

Mr. Ken Ozanne, a lecturer in the Department of Applied Mathematics, claims to have found this, the largest number of which any factor is known. R. M. Robinson was at the University of California, Los Angeles, when he found the factor which was the previous largest number for which a non-trivial factor was known. Mr. Ozanne says that his number is incomparably bigger. “Communique’’ – The newsletter of the NSW Inst. Tech. No.40 Nov/Dec. 1976.

**Nuclear Physics Conference**

The Nuclear Physics Sub-Committee of The Institute of Physics is arranging a conference on Nuclear Physics to be held at The University of Surrey from 23-25 March 1977.

**Institution of Engineers, Australia – 1978 Annual Conference**

Melbourne, April 2-7. Information from the Conference Manager, Institution of Engineers, Australia, 11 National Circuit, Barton, ACT 2600.

**Processing, Structure, Properties and Performance of Polymers**

The Materials and Testing Group and the Polymer Physics Group of The Institute of Physics, in association with the Plastics and Rubber Institute, are arranging a conference on the Processing, Structure, Properties and Performance of Polymers at the University of Nottingham from 13-15 July 1977.

**International Conference on Thermoelectricity in Metallic Conductors**

An International Conference on Thermoelectricity in Metallic Conductors will be held at Michigan State University on August 10-12, 1977. It is hoped that the Conference will include items of interest to participants at the Conference on Transition Metals to be held at the University of Toronto the following week August 15-19 1977.

The purposes of the Conference will be to: (1) Evaluate existing knowledge of thermoelectricity in metallic conductors; (2) review new experimental data and theoretical advances; (3) explore the most promising avenues of research for expanding knowledge in this area.

For further information: R. S. Crisp, University of Western Australia, Perth, Australia.
The introduction of the Spectra-Physics System 580A-04 extends the operating range of single frequency dye lasers from the orange-red region of the spectrum into the blue. This spectral region is of particular interest to high resolution spectroscopists because at least 48 electronic transitions of 22 elements can be excited with blue (450-500 nm) light. Nearly twice as many transitions occur in this range as occur in the 550 nm to 650 nm range. See chart.

The number of transitions is significantly higher if singly and doubly ionized elements are also included. And, in addition, many high resolution two-photon studies using electronically scanned single frequency dye light can now be performed. Thus single frequency blue dye lasers will become far more useful research tools than those operating in the orange and red.

For further information write or call:

QUENTRON OPTICS Pty. Ltd.
576-578 Port Road, Allenby Gardens, S.A. 5009. Tel. (08) 46 6121 — Telex AA82809
Spectra-Physics Introduces 2.0 and 2.5 Watt UV Lasers

Innovation in laser design and tube processing techniques has significantly enhanced the performance of high power ion lasers. In the two new models being introduced by Spectra-Physics, high output power, increased reliability, and longer tube life have been combined with excellent mechanical and optical stability of the resonator to provide unequalled laser performance in both the UV and the visible. Key performance specifications are noted in the chart below.

Plasma Tube Reliability
Constant, reliable output power, both in the visible and the UV, is assured with crystalline quartz Brewster angle windows. No color centers can form to degrade output power and to destroy TEM mode operation. These Brewster angle windows are attached to the tube with glass-to-metal seals. Unlike plasma tubes with organic or epoxy seals, the Spectra-Physics "hard seal tube" assures strong joints, prevents moisture diffusion, and eliminates contamination of the inner optical surfaces of the tube caused by outgassing of organic sealants. The hard seal design also permits high temperature processing to ensure removal of moisture and organic contaminants from the tube.

Higher Output Powers
Since UV power is extremely sensitive to small optical losses caused by films on the Brewster windows, a special tube processing step has been incorporated into the manufacturing procedure to chemically remove any remaining trace contaminants from the interior of the plasma tube. This process produces tubes which are much cleaner than those built using any other method. No contaminants are left in the bore to be vaporized by the plasma and subsequently transported to the Brewster angle windows. This process has improved output powers by 20% to 40%.

Laser Power Specifications

<table>
<thead>
<tr>
<th>Laser Model</th>
<th>UV Power</th>
<th>Visible Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>171-18</td>
<td>2.0 Watts</td>
<td>15 Watts</td>
</tr>
<tr>
<td>171-19</td>
<td>2.5 Watts</td>
<td>18 Watts</td>
</tr>
</tbody>
</table>

Improved Magnet Design
Magnetic field strength has been optimized for high UV power with no compromise of visible output power. A new magnet design has been incorporated to provide high field strength with conservative operating safety margins and excellent cooling efficiency. The strength of stainless steel materials and the use of heliarc welding techniques are combined to further improve magnet reliability.

Stable Power
The proprietary thermal length compensation design of the Spectra-Physics resonator reduces the coefficient of expansion of the optical cavity to essentially zero. The BeO plasma tube reaches thermal equilibrium almost instantly to eliminate thermal detuning. Stable output power is obtained even during warm-up. Tweeking for optical realignment is not required, even after significant changes of tube current.

Improved performance, increased reliability and longer lifetime are important considerations for every ion laser user. For additional product information on these high power lasers, circle number 143.

Circle No. 143

For further information write or call:

QUENTRON OPTICS PTY. LTD.
576 Port Road, Allenby Gardens, S.A. 5009. Tel. (08) 46 61 21 - Telex AAB2809
The Ice Age Cometh?

Scientists are apt to speculate amongst themselves about every hypothesis imaginable and all too often this speculation reaches the public as 'new science', or even as stark forebodings of imminent disaster. Is the earth entering a new ice age? Are record droughts or floods evidence for long-term trends? Are man's activities causing permanent changes in the weather? These are all good cocktail topics and even a Prime Minister may seek authoritative answers.

Australian Academy of Science Report Number 21 on Climatic Change sets the record straight: "There is no evidence that the world is on the brink of a major climatic change". Changes there have been but none yet outside the wide range of climatic fluctuations. Of course it is equally true that there is no evidence disproving the new ice-age hypothesis. We must just wait and see — and avoid suggestions that climate predictability is on a par with Ohm's Law for reliability.

More than in previous Academy reports, this one has involved the working scientists in the field. As well as the usual useful pieces of information there are valuable new analyses of the available data and critical evaluations of their importance. The most important aspect for Australia is the evidence for significant shifts in climatic belts. Over most of the East coast area the mean annual rainfall decreased from the end of last century through the first half of this century but has now increased again. Much of Australia's crop production is in marginal areas which can be significantly affected by such changes. Whether long-term changes are happening or not, Australian agricultural production is very much at the mercy of climatic fluctuations.

After nearly 100 years of slowly rising temperatures in the northern hemisphere, there has been a fall averaging 0.3°C since 1940. In Australia there was no rise from 1890 to 1940 and possibly a slight rise since then. These trends are consistent with other southern hemisphere data. Whereas patterns of glaciation are believed to affect both hemispheres equally these data can be explained by typical fluctuations in weather patterns. They are smaller, for example, than the change of 1.5°C which accompanied the little Ice Age in the northern hemisphere two to three hundred years ago.

Each interglacial period has been of different length in the past — varying from 5000 to 25000 years. Since our present interglacial has lasted about 9000 years it could be due to end but then it might not. The accuracy of records is not sufficient to be able to detect the rate of change over the last 30 years which would be expected at the onset of glaciation. The Academy report therefore opts for the conclusion that "the advent of the next glacial, almost certain though it is, is too remote to be relevant to realistic political thinking". The rather picturesque suggestion, given (tongue in cheek) by John Douglas Pringle in the Sydney Morning Herald on 20 November 1976: "Stop worrying about pollution and the bomb, and start studying the temperature charts" — could turn out to be quite a long-term involvement in doom-watching. Naturally enough the scientists want to be in the forefront and there is no shortage of plugs for more research and data collection in the field of weather and climate.

— R. Bird

"The congregation stood about,
Coat-collars to the ears,
And talked of stock, and crops, and drought,
As it had done for years.
'Its lookin' crook', said Daniel Croke;
'Bedad it's cruke, me lad,
For never since the banks went broke
Has seasons been so bad.'
— Said Hanrahan.

John O'Brien

"Even a casual perusal of the current journals reveals what can only be called passionate differences of opinion about what to do next. When one is groping for order, almost nothing seems evident. Cruel April brings its flood of new ideas, autumn the burial of the tired old. And one can only contrast — somewhat wistfully — the finished proportions of Newton's mechanics, the graceful arches of Maxwell's electrodynamics, with the rabble-strewn workshop that is particle physics — a column here, there a half-completed frieze, and everywhere the chaos of broken and discarded stone."

— Leon N. Cooper
Rabaul Volcanological Observatory and Geophysical Surveillance of the Rabaul Volcano

R. J. S. COOKE, Geological Survey of Papua New Guinea, Volcanological Observatory, Rabaul, P.N.G.

Introduction

Rabaul, in New Britain, is the principal town and port of the 'New Guinea Islands Region' of Papua New Guinea, and between 1910 and 1941 was the capital of New Guinea, the former colonial territory, under successive German and Australian administrations. Hence volcanic eruptions in 1937 from two centres within Blanche Bay (a volcanic caldera, Fig. 1) were of more than ordinary significance. No volcanological service was then in existence and the eruptions were a complete surprise to the local population, so that five hundred people were killed during the early activity. Surviving occupants of the town and harbour surrounds were evacuated for two weeks.

As a result of this disaster, a volcanological service was established in Rabaul before the end of 1937. The initial work involved regular inspections and temperature measurements in the active cones, but over the next few years an instrumental observatory was developed which was the forerunner to the present Rabaul Observatory. More than six months warning was given of a minor eruption in 1941-42. Observations were interrupted by the Japanese invasion of Rabaul in January 1942, and operations were not resumed until 1950.

The article surveys the mainly geophysical techniques and equipment used in current surveillance of the Rabaul volcano, and briefly describes some important recent results. The Observatory also serves as headquarters for all volcano surveillance and research carried out at the 35 active and dormant volcanoes in the country by the Geological Survey of Papua New Guinea. The present staff includes six volcanologists (graduates in geology or physics) and sixteen technical and scientific support officers.

Recorded Eruptions and Precursory Phenomena

1878 - The detailed chronology of this eruption and its precursors is not known fully, but it was certainly preceded by strong locally felt earthquakes. The Beehives (Fig. 1) subsided by about 1m, islets near the Vulcan Island eruption site were raised about 1m, and 'tidal waves' occurred in Blanche Bay at an early stage, but it is not clear which of these events actually preceded the eruption. The Vulcan Island eruption lasted a few days and was mainly submarine, while a simultaneous vigorous explosive eruption at Tavurvur lasted 2-3 weeks.

1937 - Strong locally felt earthquakes and level changes preceded this eruption. Earthquakes were perceptible in some areas for several days before the violent explosive eruption of vulcan commenced. Level changes were perceptible without instruments only during the last 6 to 8 hours before vulcan erupted, when islets and reefs in the area of the subsequent eruption rose at least 2m. Tsunamis or seiches were reported during this period. Afterwards, it was observed that the Beehive and the Sulphur Creek - Matufit Island area had subsided by about 1m, but this probably happened after the eruption commenced. A brief explosive eruption at Pavurur lasting less than 1 day accompanied the vulcan eruption, which lasted about 4 days.

1941-43 - Solfataric activity at Tavurvur did not revert to its pre-1937 level after the 1937 eruption, and symptoms of increasing activity were noted from late 1938. These included the formation of new fumaroles and patches of hot ground, changes in the composition of gases emitted, with H2S being radially replaced by increasing concentrations of HCl and SO2, and eventually, rises in the temperatures of some fumaroles from 100°C to about 400°C during the six months before the eruption started. Low-sensitivity seismographs and tiltmeters were in operation beforehand, but no precursory volcano-seismic activity or tilt effects were recorded. Measurements of strandline levels suggested subsidence of about 75mm in the Tavurvur area during the two years before the eruption. Intermittent explosive activity lasted for about 9 months.

Figure 1.

In summary, eruptive periods for which direct observations have been recorded may usefully be regarded as two, 1878 and 1937-43, during each of which 'mamatic' eruptions (in which fresh lava was produced) took place on both the western (Vulcan Island, Vulcan) and eastern (Tavurvur) sides of the caldera. In 1937 Tavurvur was not yet 'ripe' and made only a brief, non-magmatic response to the commencement of activity at Vulcan. The western eruptions were short-lived and large-scale,
while the eastern magmatic eruptions were more enduring but less intense. The precursory phenomena can be classified accordingly. Felt earthquakes and perceptible ground upheaval can be attributed to the western eruptions; elevation of land took place near the western eruption sites while only subsidence was noted elsewhere, and the stronger earthquakes in 1937 were reportedly strongest near Vulcan Island, although they were not located instrumentally. The tsunami or seiche effects presumably originated in submarine level changes. No information on prior gas activity or temperature Effects are available as both western eruptions commenced underwater. In contrast, there is no evidence of upheaval or of earthquakes in the Tavurvur area before the eastern eruptions, but a long and well-marked build-up to the 1941-43 eruption was evident in the distribution, activity, temperature and chemistry of fumaroles. Such effects may have occurred before the earlier eruptions, but escaped notice.

Surveillance

**Volcano-seismicity**

Seismic surveillance of Rabaul caldera is carried out at present by a network of eight telemetered seismograph stations (Fig. 2). Telemetry is achieved by landline in four cases and by HF or VHF radio in the other four cases; the telemetry equipment presently in use was designed and constructed at the Observatory. At each site there is an unattended short-period vertical component seismometer and associated telemetry equipment. Recording equipment for all stations is located at Rabaul Observatory, seven stations recording on individual drum recorders, and all eight together on a film strip recorder. Several other multi-component seismographs of normal seismological observatory types are operated at the Observatory.

Before November 1971, volcanic earthquakes within the caldera were rare, small, and not certainly locatable, but from 12 November onwards larger events took place and became common. Since then events have been recorded at fluctuating rates up to 500-600 per month, but overall there has been no marked rate increase. Only 10-15% of the events are sufficiently large to be reliably located, and on average about 34 events per month are felt locally at Modified Mercalli intensities up to about 5. So far, no event appears to have been recorded at seismograph stations in other parts of Papua New Guinea.

By early 1972 it had become apparent that almost all of these earthquakes were originating in the active zone illustrated in Figure 2, and three of the present eight seismograph stations were installed at sites chosen to improve the location of events in parts of this zone. Because of the short range of the recordings and the use of only vertical components, P waves alone, i.e., the first arrival at each station, are used in event location. A graphical method employing the difference in arrival times for selected pairs of stations is used in determining epicentres. The accuracy of these epicentres is improved by applying station time corrections, based on the results from a number of chemical explosions detonated within the active zone in June 1972; for well-recorded earthquakes accuracy is believed to be of the order of 200-300m. The depth of focus for most caldera earthquakes is only approximately determined, although in a few cases network geometry allows more accurate determinations. Depths appear to range from near surface to about 5-6km. Events apparently within the caldera but outside the mapped active zone are very rare, but there are frequent close earthquakes outside the caldera in several directions. There is no evidence that this close activity bears any relationship with activity in the caldera seismic zone.

![Figure 2](image)

The distribution of first motion directions, i.e., whether the ground first moves up or down at each station for a particular earthquake, is monitored routinely, as this conveys information about the mechanics of the earthquake source. Although each individual source mechanism is not uniquely determined, changes in the long-term caldera-wide pattern of source types are sought as indicating changes within the volcano at shallow depth.

The characteristics of these earthquakes, particularly depth of focus and first motion character, indicate that they are A-type events in the widely-used Japanese classification of volcanic earthquakes, i.e., of similar mechanism to ordinary 'tectonic' earthquakes. Occasionally, local-looking events of markedly different characteristics are recorded at one or more stations, but so far little success in identifying these has been achieved.

**Ground deformation**

Several techniques, presently in use, monitor ground tilt, sea level, and relative ground levels by means of tiltmeters, tide gauges, optical levelling, and gravity measurements. Of these, the gravity technique is discussed in some detail, as it has only recently been employed in volcanology, but histories are rare, and it has produced interesting results in Rabaul.

Three tilt stations are operating at present (Fig. 2), two (RAB, SUL) with 3m-base water-tube tiltmeters, and one (TAV) with 0.5m spirit level tiltmeters. The instruments are permanently installed, and are read...
daily. A fourth station, on Matupit Island, was used for six months trial in 1974 but the site proved unsatisfactory. Readings are reliable at best to about 2 and 5μrad for the two instrument types. Each station measures a tilt rate vector, and the station vectors in combination allow the identification of the focus of deformation if the station network is sufficiently comprehensive. At Rabaul, there are insufficient stations for this purpose, especially to detect deformation in the Vunakan area, and it was to correct this deficiency that the gravity programme was introduced in 1973, initially on an experimental basis. Tilt effects so far observed have involved relatively small fluctuations, and interpretation of the results is uncertain in most cases.

In principle, regular measurement of gravity at a moderately dense network of stations should give more complete information on the spatial distribution of deformation than the present tiltmeters; however the tiltmeters, read daily, are able to provide details of time variation that are not measureable in any practicable gravity programme, so that the techniques are complementary. Change in gravity at a station from survey to survey is the quantity of principal concern, rather than the gravity value itself or any type of calculated anomaly. A 10μm change in station elevation should alter the gravity value by about 3μGal, assuming only free-air effect.

Promising results have been obtained from six sets of gravity measurements since August 1973, using a La Coste & Romberg gravity meter (G252) on loan from the Bureau of Mineral Resources, Canberra. The station network has been expanded during the course of the programme and is shown in Figure 2 in its present form. Several stations were established as far inland (southwest of the caldera) as practicable to serve as a stable reference datum, on the assumption that any deformation would take place inside the caldera (but see below).

The typical standard deviation of a measured gravity interval has proved to be about 7μGal, from eight measurements at each station (four by each of two observers) relative to one or more base stations. Hence changes in elevation as small as 30mm between surveys should be measurable with 95% confidence.

The practical restriction of using only one gravity meter can introduce problems. La Coste & Romberg gravity meters are capable of excellent reading precision, but this precision cannot always be maintained in converting meter readings to gravity values because of calibration problems. Calibration tables are furnished by the manufacturer, but comparison of results from several different La Coste & Romberg meters read together over a long gravity range usually shows that correction factors, different for each meter, must be applied to reconcile the results, and that the correction factors may change with time. In addition, experience with groups of meters shows that one meter may give anomalous results relative to other meters over a limited part of its range, after application of the appropriate correction factors. The effect of such irregularities can be at least as big as 60-70μGal, and span a range of at least 5-10μGal.

Thus gravity drift between surveys could conceivably shift the reading at a station from a satisfactory range to one where anomalous readings are produced, introducing spurious changes in gravity. This could only be detected by comparison with other meters. Likewise a change between surveys in a meter correction factor could only be determined by comparison with other meters, or by measurement over a standard large interval Gravity Calibration Range. Separation of the effects of local meter irregularities and correction factor change in the presence of real but small gravity changes could be very difficult without such comparisons.

In practice, the first five sets of Rabaul gravity measurements were not affected by such problems, although a local meter irregularity appears to have been encountered at some stations during the sixth set. A newly acquired gravity meter, La Coste & Romberg G414, has also been used during 1976, and this has helped in interpreting the G252 results. Systematic changes in gravity have taken place which can be attributed to real ground deformation.

The principal deformation detected by gravity measurements has uplifted Matupit Island and tilted it up to the south relative to the Rabaul town area, which has been taken as stable on the evidence of tide gauge measurements. This deformation cannot be detected by means of gravity further than about 2.5km north of the southern end of the island. In the area of maximum uplift gravity values have fallen by as much as 65μGal, equivalent to a rise of more than 200mm in elevation. That such deformation has actually occurred is clear from visual observation of the coasts of Matupit Island. Three cycles of optical levelling of the gravity stations by Government surveyors have also demonstrated the change. The centre of the rise is probably an unknown distance offshore to the south of Matupit Island. The rate of change in gravity has declined steadily during the observation programme to date, and the deformation may have reached its peak during 1976. Recent results suggest that weak deformation may be affecting even the 'stable' inland group of stations, in a sense indicating possible downhill tilt towards the caldera. This, if real, could indicate part of a zone of subsidence around the central rising zone, a pattern which has been reported in connection with other eruptions, and which seems to have accompanied the 1878 and 1937 Rabaul eruptions.

While the maximum precision in measuring deformation by means of gravity is not as great as that obtainable from optical levelling, it is not dependent upon distance from the datum point as in levelling. A gravity programme is simpler to operate, and potentially faster than levelling, being based upon a series of spot measurements by one man, rather than a linear traverse by a party of several. The capacity of measuring direct from datum to a critical point, not available in levelling, allows individual station checks to be made between complete resurveys of the network.

Magnetic field and electrical properties

Regular measurements of total magnetic field within the craters of Tavurvur and Rabalankaia (Fig. 1) commenced in late 1973. A Sandor of Elsec proton magnetometer loaned by the University of Papua New Guinea Physics Department has been used until recently, and the programme has been carried out in co-operation with staff of that Department; Rabaul Observatory has now acquired a Geometrics proton magnetometer. Surveyed grids of marked stations at 25m intervals at Rabalankaia, and at smaller intervals at Tavurvur, allow exact site re-occupation, and the uncertainty in a total
field measurement is normally 2-3 nT in practice. Both these craters have substantial magnetic anomalies, those at Rabalanaakra ranging over 3000 nT, but so far no significant changes in the amplitude or shape of the anomalies have been detected in four measurements. The anomalies are interpreted as arising in part from buried columns of solidified lava, and should any remelting of this lava take place during the build up to an eruption, some change in the magnetic anomaly would be expected.

An experimental programme regularly remeasuring resistivity and self-potential along a permanently marked traverse in the Rabalanaakra area is being prepared.

**Thermal activity**

Temperatures are measured weekly at more than 50 gas vents and hot springs, principally at Tavurvur and Rabalanaakra cones and around the shores of Greet Harbour (Fig. 1). Ordinary glass stem thermometers of the maximum reading type are used. The highest temperatures are about 100°C and have not significantly exceeded this for at least 25 years.

**Gas chemistry**

A programme of regular collection and analysis of gas condensates has been under active development since 1972, to compare different vents, and to establish the normal range of variation under the present volcanically quiet conditions.

**Discussion**

The underlying cause of the swarm of volcanic earthquakes in the Rabaul caldera is not understood at present, but the comparatively stable and low rate of occurrence during five years, relative to what might be expected before an eruption, does not suggest the near approach of an eruption. Swarms of volcanic earthquakes have run their course at or near volcanoes elsewhere in the world without any eruption taking place. The well-defined seismic zone within the caldera does appear to be unusual judging by the rather fomless patterns of seismic activity reported at other calderas. The eastern arcuate part of the active zone in Rabaul is clearly associated with the edge of the caldera, but the interpretation of the linear western limb is unclear, as there is no geological or topographic feature apparently bearing any relationship to it. A fault zone seems to be indicated.

It is not known when the present cycle of deformation in the caldera commenced, but it is interesting to speculate that it may be associated with the earthquake swarm. The close proximity of the area of maximum measured uplift, at the southern edge of Matupit Island, and the western limb of the seismic zone is suggestive. Possible focal mechanisms for swarm earthquakes allow that the seismic zone may outline a rising area, in agreement to some extent with the pattern of deformation. However as the rate of deformation seems to have declined during a period when the earthquake swarm continued at a relatively stable rate, the existence of any relationship is uncertain and verification must await future developments. The Sulphur Creek-Matupit Island area has a history of upheaval and subsidence between eruptions, although this has rarely been quantified, and the presence there of active deformation does not necessarily imply forthcoming eruptive activity.

This article is published with the permission of the Chief Government Geologist, Geological Survey of Papua New Guinea.
Books

The following books have been received for review. Space limitations will probably not permit the publication of review or notices of all of them. Would anyone interested in reviewing a particular book please communicate with the Book Review Editor, G. A. Bell, National Measurement Laboratory, Chippendale, NSW, 2008.


PRINCIPLES OF COSMOLOGY AND GRAVITATION. M. Berry, Cambridge University Press, 1976. x + 179 pp. £2.50 (paper back).


INTRODUCTION TO SOLID STATE PHYSICS. C. Kittel. J. Wiley and Sons. 5th ed. 1976. xiv + 599 pp. £23.95.


MAGNETISM, SELECTED TOPICS. S. Foner. Gordon and Breach, 1976. xx + 748 pp. £44.00.


TURBULENCE. P. Bradshaw. Springer-Verlag, 1976. x + 335 pp. £42.60.

Book Reviews


This book contains ten papers presented at the NATO Advanced Study Institute on Anomalous Displays held in Milan in August 1975.

The first part is an introduction to electro-optics followed by two papers on the applications of holography in radar, sonar and coded aperture imaging. The remaining six papers review recent developments in display devices and cover liquid-crystal matrix displays, electroluminescent semi-conductor diode displays, gas-discharge displays, digital laser beam deflection techniques and display drive circuits.

All the papers are written by experts and are supplemented by adequate bibliographies. This volume would be a useful addition to the library of anyone interested in data processing.


The author states that he provides a unique and particularly convenient method for cross referencing his 1200 odd entries. He lists particle and γ energies and intensities and also half lives but makes no mention of K X radiations which can be prominent and useful for identifying daughter nuclides when gammas are highly internally converted or where EC is a major decay process. But the book has much more serious shortcomings making it all but useless for even moderately demanding requirements. It was published in 1976 but relies entirely on source material published in 1965 or earlier and even that material is copied with numerous errors. For example, the entry for the widely used 127Cs lists the 662 KeV γ intensity as 100% instead of (85 ± 1)% and its half-life as 26.6 y instead of (30.1 ± 0.2)y. The quoted references, seven in all, cannot be blamed for these errors. All the extensive and painstaking work done during the past 10 years to update radionuclide metrology data is simply ignored. The complete absence of statements on the accuracy of the data reflects some credit on the author's honesty but otherwise is in line with what might be expected from a careless produced book which is not even cheap.


Reviewed by G. Derrick, School of Physics, University of Sydney.

Weinberg plays down the role of Riemannian geometry in the Theory of General Relativity which he regards merely as a theory of gravity. In his view invariance under arbitrary coordinate changes is just the gauge invariance appropriate for fields of mass zero and spin two. This nongeometrical attitude is perhaps to be expected from such a renowned particle physicist, but it may offend those who, following Einstein, maintain faith in the ultimate understanding of matter in geometrical terms.

The book is comprehensive in scope and includes a wealth of material not normally included in similar texts. The five parts of the book are:

i. A 62 page historical introduction to and summary of Special Relativity.

ii. A fairly standard development of the General Theory starting from the principles of equivalence and covariance, 106 pages.

iii. 102 pages of applications, including the classic tests, post-Newtonian mechanics, gravitation radiation, quantum theory of gravitons, stellar equilibrium and collapse, black holes.


v. Cosmology -- the Robertson-Walker metric, red shifts, cosmic distance scales, cosmological models, intergalactic emission and absorption processes, formation of galaxies, thermal history of the universe, 225 pages.

These diverse topics are treated with great thoroughness and there are extensive references. This is NOT a suitable introductory text. A novice might well be thoroughly confused by the abbreviated notation of the section on the principle of equivalence. However it is a splendid book for a second look at Relativity and an excellent source of data and references. I recommend it highly.


Reviewed by D. M. Eagles, National Measurement Laboratory, CSIRO, Chippendale, NSW.

Research on solids with such strongly anisotropic properties that they may be regarded as almost "one-dimensional" has expanded very rapidly in recent years, stimulated in particular by reports of a group from the University of Pennsylvania in 1973 of very large enhancements of conductivity in a particular direction in the molecular crystal tetraphhatofullerene tetra
cyanonitridimethan (TTF-TCNQ) near 60K. In this book of
seventeen chapters, both physicists and chemists attempt to survey the status of research on “one-dimensional” solids as at September 1974. Broadly speaking their intention is adequately fulfilled.

About a quarter of the book is concerned with magnetic properties of low-dimensional systems, several lectures deal with chemical and preparative aspects of one-dimensional compounds, and one lecture is about W. A. Little’s proposal for high-temperature superconductivity involving pairing of electrons mediated by electronic excitations instead of by phonons. However, to the reviewer the most interesting lectures are those concerned with details of studies of the compounds TTF-TCNO and K$_2$[Pt(CN)$_4$][Br$_2$]$_2$(H$_2$O) (known as KCP). The description of experimental work used to verify the twenty-year-old predictions of Peierls and Frohlich about the properties of such compounds with nearly one-dimensional conductivity makes fascinating reading, and may help to realise the possibility of considerable further enhancement of conductivity when sufficient control of specimen preparation is obtained.

The presentation is in the form of reproduction direct from typescripts, and several of the articles contain an excessive number of uncorrected typing errors – the reviewer having noted about forty in all. Nevertheless, this is a timely book in a fast-expanding field, and can be expected to serve as a useful introduction to the subject for several years to come.


Reviewed by W. D. Parkinson. Geology Dept. The University of Tasmania.

The simplest example of the relation between the distortion of a body and the forces applied to it is Hooke’s Law applied to the stretching of a perfectly elastic beam. This can be generalized in two ways – we can consider hydrostatic and shear stresses in a continuous medium, or finite strains, or non-linear bodies in which creep phenomena occur, or viscoelastic bodies involving linear differential relations between stress and strain. This book confines itself to the last of these. Elastic solids and viscous liquids involve first order relations, Maxwell and Kelvin substances second order, and so on.

Nowhere are examples given of materials that behave like the mathematical models discussed. To quote from the preface, “There is, however, no reference to specific applications or materials, which, in our fast changing world, are here today and gone tomorrow”. The earth scientist, for whom this subject is of vital and baffling interest, and whose materials have been here for some time, will find little help in this book.

- Great use is made of correspondence principle by which a problem involving a viscoelastic body can be solved using the solution of the corresponding problem for an elastic body. Seven of the eight chapters are confined to the distortion of beams. The book will therefore appeal most to the engineering student whose library already contains books on other aspects of the subject.

In summary, the author accomplished very well what he set out to do, namely to give an introduction to the mathematical techniques of dealing with infinitesimal strains in viscoelastic materials. But it is a pity that he did not undertake to cover a broader field.


Reviewed by J. C. Macfarlane, National Measurement Laboratory

In the foreword, Dr Grasse states that he intended this book for the experimental physicist who needs a ready access to the theoretical background in order to analyse his results. The measure of his success has to be judged in relation to existing textbooks which, despite its assertion to the contrary, have attempted to fulfil the same need.

The Superconducting State has 6 chapters which cover the following major topics: historical survey, BCS theory, Ginsburg-Landau theory, flux quantization, Type-II superconductors, high-field superconductors, and the Josephson effects. At the end of each chapter a concise summary brings together the various topics covered - an excellent arrangement which should be a feature of all textbooks.

The chapter on high-field superconductors is a useful descriptive summary, but the treatment of the Josephson Effects is brief and closely resembles a chapter in Feynman’s Lectures in Physics (1965).

The final sections of the book deal with the operation and application of rf SQUIDS. The material is too loosely presented to appeal to a newcomer to the field, yet not sufficiently detailed for the specialist.

In summary Dr Grasse has written a concise, readable account of superconductivity which is a useful supplement to earlier texts, but fails to stand on its own as an experimentalist's handbook. At the price charged for it in Australia, The Superconducting State is something of a luxury.


Reviewed by W. S. Woolcock, Research School of Physical Sciences, The Australian National University.

Many ideas have been developed in the attempt to understand the dynamics of strongly interacting particles. The pion-pion system, because it is relatively simple, provides a laboratory in which these ideas can be formulated and tested. On the other hand, since the pion-pion system is not accessible to direct experimental observation, obtaining a reliable body of information on it has been difficult.

The book is a balanced and comprehensive account of the present state of our knowledge of pion-pion interactions. It presents the relevant experimental results in detail, discusses the difficulties in their interpretation and summaries very well the information obtained from them. On the theoretical side, it gives a ‘cross-section’ of the field of hadron dynamics. There is extensive discussion of the way in which the analytic properties of scattering amplitudes (together with crossing symmetry and unitarity) have been used to try to understand pion-pion interactions. But other theoretical ideas are there too – Regge poles, duality, the quark model, current algebra.

The book is well written and has a comprehensive list of references (about 700 in all). It is a must for all research workers in high energy physics, including postgraduate students, at least as a reference work, and preferably for more detailed study.

Corrections to the Annual Report

Page 205 – Consolidated Statement of Income and Expenditure.
line 1 . . . 1975
2099 Surplus (Deficit) from years activities before extraordinary items and after making the following charges and provision.

Page 204 – Consolidated Balance Sheet
Current Liabilities – line 2 . . . for 1648 read 1664

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Students have seldom written for the Australian
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As from February 1977, all correspondence
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