the australian physicist

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Vol. 8, number 3

MARCH 1971

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Vol. 8, No 3

THE PSSC PHYSICS COURSE AND PERFORMANCE AT FIRST-YEAR UNIVERSITY LEVEL

B. A. McInnes
Department of Physics, University of Queensland

During 1966 the Board of Senior Secondary School Studies in Queensland, on the recommendation of its Special Committee in Physics, decided on the introduction of the PSSC (Physical Science Study Committee) course for the final two years of secondary education. For a number of reasons the course was introduced on a pilot basis into 15 schools (some 20 per cent. of total student population) in 1968 and into the remaining schools in 1969.

In 1970, students entering first year physics courses at the University of Queensland had been trained either in the traditional style of syllabus or in the PSSC course. Use has been made of this opportunity to investigate whether there is any significant difference in performance at the first-year university level between the two groups of students and whether this difference, if it exists, could be attributed to the PSSC course. This investigation has, in the main, been restricted to students following the Physics Ia course, although reference is made to other first-year physics courses in this article.

The Physics Ia course at the University of Queensland is taken by all engineering students and those science students who, at least initially, plan either to proceed to a pass degree in physics or to include a substantial component of physics units in their degree (e.g. students proceeding in mathematics, physical chemistry, metallurgy etc.). The number of students enrolled in Physics Ia in 1970 was about 420. Of these 108 had been trained in the PSSC course. The Physics Department also offers, at the first year level, a Physics II course for those science students planning an honours degree in physics (1970 enrolment, about 50) and a terminal Physics Ib course both for science students planning a biologically-oriented degree and as a service course for a number of faculties (e.g. medicine, veterinary science, dentistry etc.). The 1970 enrolment for this course was about 530.

Four separate lecture streams were scheduled for full-time students in Physics Ia. One of the streams was restricted to students who had taken the PSSC physics course; with the exception of a few students enrolled for first-year surveying, the other lecture streams were restricted to students who had taken the traditional-syllabus course. A fifth lecture stream was scheduled in the evening for some 25 part-time students. All lecturers involved with Physics Ia lecturing in 1970 had had previous experience at this level. A study of examination pass-rates in 1969 had shown no significant difference in the performance of students subjected to separate lecture courses from three of the personnel involved in the 1970 lecturing. Table 1 shows the mean mark (not out of 100) attained by students in the three separate streams in the mid-year and final examinations in 1969. The lecturer in charge of group C was responsible for the PSSC-trained students in 1970; he also undertook half the lecturing for one of the remaining lecture-streams.

In an analysis of the results of the 1967 and 1968 Senior (school terminal) Physics examination, it was found that entrants from the pilot schools had a superior performance to the total school population. Hence it may be thought that students matriculating into university from these pilot schools would, regardless of course content at secondary school, have a better first-year university performance than the total population. Somewhat surprisingly, this is not reflected in the results for Physics Ia in 1968 and 1969. The 1968 results are identical; in 1969 students matriculated from the PSSC pilot schools performed slightly poorer than the total population. Nevertheless, in this study, the performances of the PSSC-trained students and of the non-PSSC-trained students are compared in other subjects besides physics.

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
<td>mid-year exam</td>
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<td>38</td>
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</tr>
<tr>
<td>final exam</td>
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<td>28</td>
<td>28</td>
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Median marks for three separate lecture streams, Physics Ia 1969.
Table 2

<table>
<thead>
<tr>
<th>Group</th>
<th>Score</th>
</tr>
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<tbody>
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</tr>
<tr>
<td>group</td>
<td>10 15 20 25 30 35 40</td>
</tr>
<tr>
<td>PSSC</td>
<td>0 11 29 62 83 96 100</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>3 16 49 79 93 100 100</td>
</tr>
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</table>

Percentage of students (PSSC and non-PSSC trained) below quoted score, test A Physics Ia 1970.

Table 3

<table>
<thead>
<tr>
<th>Group</th>
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<tr>
<td>group</td>
<td>10 15 20 25 30 35 40 45</td>
</tr>
<tr>
<td>PSSC</td>
<td>3 7 26 53 80 97 99 100</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>0 5 28 67 89 99 100 100</td>
</tr>
</tbody>
</table>

Percentage of students (PSSC and non-PSSC trained) below quoted score, test B Physics Ia 1970.

Table 4

<table>
<thead>
<tr>
<th>Group</th>
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<tbody>
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<td></td>
<td></td>
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<tr>
<td>group</td>
<td>10 15 20 25 30 35 40 45</td>
</tr>
<tr>
<td>PSSC</td>
<td>2 2 22 42 72 92 97 100</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>1 3 31 65 87 99 100 100</td>
</tr>
</tbody>
</table>

Percentage of engineering students (PSSC and non-PSSC trained) below quoted score, test B Physics Ia 1970.

Table 5

<table>
<thead>
<tr>
<th>Group</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>group</td>
<td>10 20 30 40 50 60 70 80</td>
</tr>
<tr>
<td>PSSC</td>
<td>2 8 14 39 56 76 91 100</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>3 11 29 50 76 90 99 100</td>
</tr>
</tbody>
</table>

Percentage of students (PSSC and non-PSSC trained) below quoted score, test C, Physics Ia 1970.

All Physics Ia students took three two-hour examinations during 1970. The first (test A) was a 45 question multiple-choice examination held in June, the second (test B) was similar to test A but held in November; the third (test C) was an essay-type examination also held in November.

Table 2 shows the percentage of students in each group with a total score in test A less than a given value. A test of the null hypothesis, that the students in the two groups would perform similarly, using the Kolmogorov Smirnov two-sample non-parametric test [Siegel, 1956], shows that this hypothesis must be rejected at the 0.01 significance level ($\chi^2 = 12.9$).

Table 3 shows, in a similar fashion, the performance of the two groups in test B. Here the null hypothesis is rejected at the 0.05 significance level ($\chi^2 = 6.3$). When only the engineering students are considered, using the data of table 4, the null hypothesis is rejected at the 0.01 level ($\chi^2 = 9.3$); on the other hand there is no significant difference in the performance of the two science groups (PSSC and traditional syllabus) in test B.

Table 5 shows, as before, the situation for test C. Again the null hypothesis is rejected at the 0.01 level ($\chi^2 = 12.9$); the null hypothesis is also rejected at the 0.05 level for the separate cases of engineering and science students.

When the superior performance of the PSSC-trained students was noted in test A, it was thought that this may have been explained by the fact that these students had had more experience in this style of examination. The 1969 PSSC Senior Physics examination was a multiple-choice and short answers; the corresponding traditional-course examination was of the essay type. However, this superior performance carried through not only to test B but also to test C.

In spite of the performance in Physics Ia in 1968 and 1969 of students from the pilot schools with respect to the total population, it might still be argued that, in 1970, students from these schools were intrinsically better, regardless of the course studied at school. To check this, the first-year results of engineering and science students in other disciplines than physics were analysed. First-year engineering students take a year course with physics, chemistry, pure mathematics, and applied mathematics as common science-type subjects; first-year science students take a unit course, but almost every full-time Physics Ia student who was not repeating the course, also took chemistry and pure mathematics.

Table 6 shows, in the same manner as previous tables, the normalized scores for the year's work in the four common subjects for the two groups of engineering students. The same null hypothesis—that performance for the two groups is identical—was tested for each subject in turn. With a significance level of 0.05, the hypothesis is rejected for physics ($\chi^2 = 6.3$), but cannot be rejected for chemistry ($\chi^2 = 3.3$), pure mathematics ($\chi^2 = 1.4$) and applied mathematics ($\chi^2 = 1.1$).

Table 6

<table>
<thead>
<tr>
<th>Subject</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Subject</td>
<td>group</td>
</tr>
<tr>
<td>Physics</td>
<td>PSSC</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>0 0 1 15 28 53 74 88 99 100</td>
</tr>
<tr>
<td>Chemistry</td>
<td>PSSC</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>0 3 15 25 32 61 85 95 99 100</td>
</tr>
<tr>
<td>Pure Maths</td>
<td>PSSC</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>0 5 10 15 29 48 69 76 93 100</td>
</tr>
<tr>
<td>Applied Maths</td>
<td>PSSC</td>
</tr>
<tr>
<td>non-PSSC</td>
<td>0 4 13 21 30 49 73 84 94 100</td>
</tr>
</tbody>
</table>

Percentage of engineering students (PSSC and non-PSSC trained) below quoted normalized score for full year's work, Physics Ia, Chemistry I, Pure Mathematics I, and Applied Mathematics I, 1970.
Table 7

<table>
<thead>
<tr>
<th>Subject group</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 50 65 80 90 100</td>
<td></td>
</tr>
<tr>
<td>Physics PSSC</td>
<td>6 16 56 88 98 100</td>
</tr>
<tr>
<td>Physics non-PSSC</td>
<td>6 31 78 96 100 100</td>
</tr>
<tr>
<td>Chemistry PSSC</td>
<td>7 18 67 87 91 100</td>
</tr>
<tr>
<td>Chemistry non-PSSC</td>
<td>14 41 78 94 99 100</td>
</tr>
<tr>
<td>Pure Maths PSSC</td>
<td>11 20 55 74 91 100</td>
</tr>
<tr>
<td>Pure Maths non-PSSC</td>
<td>2 22 69 89 99 100</td>
</tr>
</tbody>
</table>

Percentage of science students (PSSC and non-PSSC trained) below quoted normalized score for full year's work, Physics Ia, Chemistry I, and Pure Mathematics I, 1970.

In table 7 the scores for the year's work in the three common subjects for the two groups of science students are shown. (Less information was available for these students; divisions have been based on the basis of awards such as pass, credits, etc.; essentially this reproduces the normalized scores of table 6 with less subdivisions.) For these science students the null hypothesis is rejected for both physics and chemistry (χ² = 6.4 and 7.0), but not for pure mathematics (χ² = 3.0).

There seems little doubt that, for the engineering students, the PSSC course gave a marked advantage in first-year university work. The situation is not as clear-cut for the science students. But even here, in spite of the test B and the Chemistry I results, there is a strong indication that those with PSSC training had an advantage over their fellows. It is interesting to note that, whereas all engineering students undertook Physics Ia, a number of science students, allegedly with superior ability, took the Physics II course. In other words, the top science students were, in general, missing from the Physics Ia course. The small sample size involved in the Physics II course does not allow any useful statistical information to be derived from the data.

A further point of interest is the lack of differentiation in performance for veterinary-science students taking the Physics Ia course. Veterinary-science students in Queensland tend to be drawn from among the weaker matriculants. The median marks for those students who formed part of three separate lecture streams, the first of which was for PSSC trained students, were 57, 56, and 58. This strengthens the impression that the advantage of the PSSC course as a preparation for tertiary studies is a function of the ability of the student; it is the more able students who derive most advantage from the PSSC course.

The question as to the reason for the better performance of the PSSC trained students remains to be answered. Here a more subjective approach must be adopted. The writer noted, with pleasure and not a little surprise, a far more vital attitude to Physics Ia by these students than he had previously experienced in a number of years lecturing at this level. This was especially evident in tutorial sessions. Perhaps this can be explained by the nature of the course itself. As opposed to the traditional courses, the PSSC course involved a more questioning and analytical approach. Emphasis is more on understanding than on rote-memory and regurgitation. In addition, in its presentation, much more active participation on the part of the student is required. These features have apparently led to the able student, who has experienced the course, being prepared to question and discuss at the first-year university level and being able to cope better with the unavoidable but unavoidable task of passing examinations.

Reference

**PROFILE OF A PHYSICS DEPARTMENT**

QUEENSLAND INSTITUTE OF TECHNOLOGY
(DARLING DOWNS), TOOWOOMBA

**P. T. Dobney**

The QIT (Darling Downs) is located in the city of Toowoomba, which has a population of 60,000, and is set on the edge of the Great Dividing Range at an elevation of approximately 2000 feet. Brisbane lies to the east, about 1½ hours driving time away. The Institute is located on a 200-acre site, 5 miles south of the city. The first new building was completed in January 1967. A sum of 4.5 million dollars has been spent or committed for the 1970/72 triennium. The Institute has been given the responsibility of providing vocational-type higher education for the people of Southern Queensland, excluding the Brisbane area. It provides facilities for students from as far north as Maryborough, east to Ipswich, south to the NSW border, and west to the Northern Territory border. In order to assist students living outside the Toowoomba area, two

*The Australian Physicist, March 1971*
residential colleges catering for 120 students have been established. One of these colleges has been established by the Darling Downs Association of Advanced Education, formed by the people of Toowoomba, to raise money by donations and art unions. At present, departments of Applied Chemistry, Geology, Mathematics and Physics, Business and General Studies, and Civil, Agricultural, Mechanical and Electrical Engineering, are offering 3—4 year courses. In 1972, departments of Fine Arts, and Education, are to be established. Students enrolments are expected to rise rapidly from the present figure of 450, to approximately one thousand, and then somewhat more slowly to a total campus population in excess of two thousand. Autonomy is expected to be granted early in 1971.

The Physics Department is staffed at present by four lecturers and one senior lecturer. As well as offering service subjects for other departments, it offers a three-year course for the Associate Diploma in Science (Physics). In the first year, students study general courses in Physics, Mathematics, Chemistry, and either Biology or Geology. In their second and third years a basic core of Physics, Mathematics, Electronics, and General Studies is offered, with 8 hours per week of elective studies. These electives constitute units offered by other departments, and enable students to gain expertise in the subject areas best suited for future careers in teaching, industrial and scientific physics, or geophysics.

Twenty-eight experimental sessions are completed by students in the general first-year Physics subject, It has not been possible to duplicate these experiments, and because of this, with weekly laboratory sessions, students often are expected to perform experiments before they have encountered the relevant theory in lectures. It is the author’s opinion that many students enrolled in general first-year Physics subjects are not doing the subject because they want to do it, but because they have to do it. These students are not particularly interested in Physics when they come to us, and they lack the motivation to engage in self-study of the theory necessary to understand a particular experiment they are expected to perform. The ‘why is it so’ approach does not work with these students. At present the theory is presented to students in note form in the laboratory sheets, and as much help as possible is given by the demonstrator in charge of a group. In 1972 or 1973 a new approach is to be tried when more laboratory space becomes available. It is planned to conduct lectures entirely during the first two terms, without concurrent weekly experimental sessions, and then conduct 2—3 laboratory sessions per week following the completion of lectures. All experiments can then be used for reinforcement and extension of theory presented previously, in addition to teaching techniques, instrumentation, etc. This may then make experimental sessions more meaningful for the less interested students.

The major innovation in our second- and third-year experimental work is that, in addition to the more conventional type of experimentation in acoustics, ultrasonics, vacuum technology, X-ray crystallography, electronics, etc., local industry and research establishments are asked to provide projects for these students. This year, investigations of such diverse projects as the construction of cheap ultra-fine thermocouple junctions, the laboratory calibration of micrometeorological instruments, a simple transmitter for indicating the temperature at the bottom of turtle nests, and improvements in microwave ovens have been initiated.

A policy of continuous assessment is gradually being implemented in this Institute. In 1970, final examinations counted for 60 per cent of the marks awarded in each subject. The remainder of marks were allotted for terminal tests, assignments, practical work, etc. In the first-year Physics course, testing during the year, and in the final examinations during 1970, was carried out using short objective-type tests and open-book examinations. In 1971 it is planned to allot approximately 40 per cent of marks for a final examination, 40 per cent for fortnightly tests, and 20 per cent for work in assignments and experimental work during the year.
INTRODUCTION

There has been a rapid increase in sophistication of vacuum technology in recent years, and this has been coupled with a widespread application of this technology in industry and research establishments. This has placed on tertiary education establishments the responsibility of providing their students with the necessary background to enable them to cope with these advances when they take their place in industry, etc.

In Australia, until recently, very few formalized courses in vacuum technology were available to students at any level. Since 1962 the SAIT has provided courses in vacuum technology for its students, as well as several extension courses. These courses have been presented to students at all academic levels, i.e., from certificate up to third-year degree diploma students. The courses offered have been tailored to the particular requirements of the students.

In March 1970 a new campus was opened on a much larger site at 'The Levels', some 7 miles north of Adelaide. Included in the physics complex is a large, separate, vacuum-technology laboratory designed with ample room for expansion. It is this laboratory which handles the majority of the students attending the various vacuum-technology courses at the SAIT.

There is a smaller laboratory containing the more sophisticated experiments, still in operation at North Terrace, which caters for the 2nd/3rd year degree/diploma physics students. This laboratory will eventually be housed at The Levels (March 1972) in a new physics wing.

COURSES OFFERED

1. Certificate students

There is obviously a large demand by industry, research establishments, etc., for technical staff who are able to efficiently operate and maintain vacuum equipment of all types. To this end a 10-week programme covering many aspects of vacuum technology has been incorporated in the course for the Certificate in Applied Physics. This consists of 10 two-hour lectures, 9 two-hour practicals, and visits to industrial firms which utilize vacuum technology.

2. Degree/diploma students

This category forms the greatest teaching load with 100–150 students in any one year passing through the laboratory. They are first year degree/diploma students from a variety of disciplines (e.g., mechanical engineering, electrical engineering, physics, etc.) whose work is likely to benefit from the course. The duration of the course is four weeks; the first week consisting of a 3-hour lecture-cum-tutorial carried out in the laboratory itself. Thereafter the students have a one-hour lecture followed by a two-hour practical. The students are usually in groups of 12–14, although the laboratory can handle up to 18 students at any one time.

Students studying for a Diploma in Technology in Applied Physics receive a further series of lectures and practicals, at a more advanced level, in the second or third year of their course. These students make extensive use of vacuum facilities in their project work.

3. Extension courses

In the past four years several extension courses in high- and ultra-high-vacuum techniques, have been given at the Weapons Research Establishment, Salisbury. The classes have been well attended by a wide range of technical personnel.

Plans are under way to introduce a new, industrially orientated extension course in 1971, to cater for the large number of concerns, which have staff directly involved in the application of vacuum techniques.

LABORATORIES

1. Layout

The 'first year' laboratory at The Levels is a spacious 36 ft × 23 ft (to allow for the inevitable increase in student numbers), and is kept at a constant 70°F. To make best use of the large central floor space two 'pillars' were installed (see plates 1, 2, and 3) to serve as access points for water and power. Each pillar is capable of serving three systems at any one time.

Wherever necessary, transparent perspex side and top panels have been fitted to commercial pumping units in order to expose the pumps, valves, and tubulation, for student examination.

As well as many pertinent wall diagrams, a glass-fronted display cabinet has been mounted on one of the walls. This is used to display examples of the many applications of vacuum-deposited thin films (e.g., sectional view of the internal aluminizing of a television tube, aluminized car fascias, mirrors, microcircuits, etc.).

Glass grease-pencil boards are used to avoid the inevitable sealing and dust problems caused by chalk.

The more advanced experiments are at present carried out at North Terrace. These will be transferred to
EXPERIMENTS

The Levels by March 1972. This new laboratory will house:

(a) a vacuum-technology and technology laboratory, to carry out the more advanced experiments, projects, etc.
(b) A vacuum-service laboratory, to be used as a support laboratory for the physics department in general, e.g. the production of thin films to study their electrical, optical, and mechanical properties, etc.

This laboratory complex will be kept at a constant 70°F, pressurized to reduce the possibility of dust entering the laboratories, and will have a cooled, recirculated water supply available for diffusion-pump systems.

2. Experimental work—elementary

Many of the experiments in the first year ‘Levels Complex’ were designed to cater for the fact that the majority of the students passing through the laboratory, have not seen a rotary or a diffusion pump, and are unlikely to have operated a vacuum system. This lack of knowledge is in contrast with many other laboratories (e.g. electrical, optical, etc), where the students would have used, or at least seen, a reasonable proportion of the equipment.

Every possible effort has been made to incorporate as wide a variety of components as possible in the experiments.

There are eight different experiments available in the first year laboratory. All experiments are supplemented by questions, which the students are encouraged to discuss with the demonstrator.

Experiment 1—Dismantling a two-stage rotary and diffusion pump/baffle-valve combination.

The students are expected to completely dismantle the pumps and baffle-valve assembly. This gives them an opportunity to clarify the operating principles of three of the more commonly used vacuum components.

The author has always found it advantageous to partially dismantle a rotary pump (exposing the rotor, rotor blades, and pumping chamber) and diffusion pump, when dealing with the topic in lectures.

Experiment 2—Pump-down characteristics

This experiment introduces the student to a standard pumping facility, consisting of a metal workchamber evacuated by an air-cooled diffusion/rotary pump combination. The system deliberately contains many of the more commonly used vacuum components.

The experiment itself is intentionally simple and straightforward, and ideally should be completed by the students before passing on to any of the other experiments in the laboratory. Student numbers prevent this being done, in general, but it is duplicated so that at least four students can start with this experiment.

The students use this system to (i) familiarize themselves with the general operating principles of a standard pumping facility, (ii) obtain pump-down characteristics for both pumps, and (iii) learn to differentiate between real and virtual leaks.

Experiment 3—Sorption pump

Using a single sorption pump, various molecular-sieve materials (e.g. zeolites, charcoal, and silica-gel) and a small workchamber, students study the operation of the pump, and obtain pump-down characteristics for each sieve material.

Experiment 4—Pumping speed

Here the students determine the pumping speed of a two-stage rotary pump at various operating pressures, and draw up a pumping speed versus pressure curve to compare with the standard characteristics.

The method involves measuring the pressure difference across a long tube, whose conductance is deter-
mined from its dimensions and a knowledge of the average pressure in the line (to allow for viscous flow conditions).

Experiment 5—Gauge calibration

This experiment serves a dual purpose as it introduces the student to special procedures involved in the use of (i) a 'glass' system and (ii) a McLeod gauge.

The students use the system to calibrate a thermal-conductivity gauge.

Experiment 6, 7—Vacuum deposition of a thin film

Experiment 6, temporarily at North Terrace, involves introducing the students to the procedures used in (i) the preparation of the substrate (e.g. chemical and ultrasonic cleaning, etc.) and (ii) the deposition.

As well as aluminizing several glass substrates (a few of which are made deliberately greasy), the students are expected to interpret any variation in the work-chamber pressure which occurs during, and after, the deposition.

Experiment 7 allows the student to use a commercial evaporation unit (c.f. the system used in experiment 6, which was made at the Institute), to carry the substrate and work-chamber procedure one stage further with the aid of a ion-bombardment unit and to study (and explain) the changes which occur in the electrical characteristics of a nickel-chrome thin film during the transition from work-chamber to atmospheric conditions. This is achieved by admitting a small leak to the now isolated work-chamber, and monitoring the rate of increase in the electrical resistance of the film.

Experiment 8—Critical backing pressure

A study is made in this experiment of the variation in critical backing pressure of a 2-inch diffusion pump, as the power input to the pump boiler is changed.

3. Experimental work—advanced

Amongst the more advanced experiments being carried out at North Terrace are:

(a) Thin-film measuring techniques—interference microscope, quartz crystal oscillator, etc.
(b) Hot/cold-cathode ionization-gauge studies—Orbitron (hot/cold cathode), modulated Bayard-Alpert gauge, etc.
(c) Freeze-drying methods.
(d) Thermal conductivity of gases.
(e) Electron-beam evaporation.
(f) Ultra-high-vacuum techniques, residual-gas analysis, etc.
(g) Laser and plasma studies.

Financial Outlay

Although capital outlay on vacuum equipment in the Physics Department at SAIT has exceeded $30 000, it is the considered view of the author that a worthwhile group of introductory experiments (e.g. experiment numbers 1, 2, 3, 4 and 6) could, with access to workshop assistance, be set up for less than $3 500.

A further $20 000 is to be spent on equipment during the next two years in an effort to extend the more advanced projects. These projects will then form a firm base from which to develop future post-graduate courses at the SAIT.

Conclusion

The article conveys something of the educational aims and flavour of a vacuum-techniques course, and suggests that this area of science and technology has come of age as tertiary study.

The author looks forward to the continued expansion at all tertiary institutions (i.e. institutes and universities) of courses in vacuum science and technology. This growth will be accelerated by the interchange of ideas and experimental programmes between these institutions, and by interest and help within the associated industries.

NOTES AND NEWS

1972 International Conference on Thin Films, Venice, Italy

The 1972 International Conference on Thin Films, promoted by the International Thin Film Committee, will be held in Venice, Italy, on 15-19 May 1972, under the sponsorship of SIF (Italian Physical Society) and of AEI (Italian Electrical and Electronic Association).

The major topic of the conference will cover the 'Application of Thin Films'. Aside from the traditional items as nucleation and growth, charge-transport phenomena, mechanical and optical properties, sessions on influence of substrates on film properties, chemistry of thin films, application in optics and mechanics, and thin film devices (including MIS structures, amorphous films, cermet and metal film resistors, thin film capacitors and inductors, and so on) are planned.

Prospective contributors of original papers are kindly requested to submit a preliminary synopsis typewritten on one page, including title, authors and affiliation, text, figures and references, if any; everything must be contained within a 16.5 cm by 21.5 cm rectangular area. The abstracts should be sent before 1 December 1971, to Professor N. Minnaja, Program Chairman, Sezione Progetti e Studi, Honeywell Information Systems Italia, I-20010 Pregnana Milanese, Italy.

Proceedings of the Conference will be published in an international scientific journal.
Professor Street Elected President

Professor Robert Street has been elected President of the Australian Institute of Physics. This was announced at the Annual General Meeting of the Institute at Armidale, NSW, on 11 February.

Professor Street is Chairman of the Department of Physics at Monash University, having been appointed in 1960 as Foundation Professor of Physics. A graduate of London University, he previously held appointments with the UK Ministry of Supply and the Universities of Nottingham and Sheffield. His research interests are in solid-state physics. He is also Chairman of the National Standards Commission, a member of the Australian Research Grants Committee, the Australian Atomic Energy Advisory Committee and the Science and Technology Advisory Committee of the Metric Conversion Board.

Dr F. J. Jacka, Director of the Mawson Institute of Antarctic Research in Adelaide, was elected Vice-President of the Institute. Other members of the Executive Committee, who were re-elected, are:

- Honorary Treasurer : Dr J. K. Mackenzie
- Honorary Registrar : Dr R. D. B. Fraser
- Honorary Secretary : Dr J. G. Campbell

WA Branch Notes

Mr G. C. Kerrigan of the Physics Department at the WA Institute of Technology is currently visiting the Philips Laboratories at Eindhoven in the Netherlands, where he is contributing to an X-ray fluorescence analysis research and development program.

A new appointee in the same Department is Dr B. H. O’Connor, who recently completed a three year term as a Queen Elizabeth II Fellow in the Department of Physics at the University of WA.

Dr R. B. Roof of the Los Alamos Scientific Laboratory has returned to the USA after spending a year’s sabbatical leave at the University.

THE REGISTER

Changes in Membership from 14 December 1970 to 8 February 1971

Fellowship

(a) New Election
Legge, G. J. F. University of Melbourne, Vic.

(b) Transfer
Garman, E. H. University of Botswana, Lesotho, and Swaziland, Southern Africa

Associateship

(a) New Election
Chute, J. H. Trace Element Laboratories Pty Ltd, WA

(b) Transfers
Gorrock, M. J. Weapons Research Establishment, SA
Ip, J. (H. K.) National Semiconductor (Pte) Ltd, Singapore
Walker, R. South Australian Institute of Technology
Westphalen, J. A. South Australian Institute of Technology

(c) Resignations
Crompton, J. W. (SA)
Kosche, K. W. (Vic)
McCabe, M. K. (SA)

Graduateship

(a) New Elections
Cheeseman, G. L. Department of the Army, Vic.
Maclay, R. W. Dept of Education, NSW
Mills, D. R. University of New England, NSW

(b) Transfers
Badham, C. R. Macquarie University, NSW
Grace, T. S. Department of Education, NSW
Hickey, G. T. University of New South Wales
O'Keefe, M. A. CSIRO Division of Tribophysics, Vic.
Thatcher, J. D. Department of Technical Education, NSW

(c) Resignations
Chan, W. C. (WA)
Spanney, K. D. (WA)

Students

(a) New Election
Holland, P. A. (WA)

(b) Resignations
Gapper, G. (SA)
Jackson, P. B. (NSW)
Mander-Jones, E. A. (SA)

Subscribers

Resignations
Clack, D. J. (NSW)
Facer, R. A. (NSW)
Nickolai, M. B. (SA)

42 The Australian Physicist, March 1971
The Affairs of the Group

At a meeting of the AIP Council in October 1970, attended by the Chairman, it was felt that successful Groups fulfil a real need in AIP activities. Where a Group meets regularly in its home state and on a national basis, it was suggested that Groups should be assisted as far as possible.

The Vacuum-Physics Group is such a Group receiving consideration. It has been given a special visiting-lecturers grant, enabling several visits to be undertaken every year between Sections in the Eastern and Southern States, alternately, one visit should be possible sometimes between one of these States and the West Australian Section.

The importance of Groups has been further recognized by the AIP Council by requiring attendance of Group Chairmen or proxies at one specified Council Meeting each year; this attendance will be supported financially.

In view of the Vacuum-Physics Group’s emergence in the international vacuum scene through the publication in Vacuum of the Proceedings of its First National Symposium and the likelihood, early this year, of two special issues of Vacuum devoted to the Second National Symposium, it is felt that it should take up membership of the International Union for Vacuum Science, Technique and Applications (IUVSTA). With the further improvement in the Group’s funds, and with AIP approval, affiliation has been applied for by taking out two contributory shares. The Group will therefore be kept abreast of international conferences in the vacuum field, especially the Fifth International Vacuum Congress due to take place in October 1971 at Boston, USA.

National Committee

The NSW Section expects to hold its first meeting this year on 23 February, when it will formally hand over the National Committee to the South Australian Section for the ensuing two years.

Some members of the interim committee are as follows.

Chairman: Mr J. Ward, Dept. of Supply, Weapons Research Establishment, Building 37, Salisbury, SA 5108.

Vice-Chairman: Mr R. Walker, South Australian Institute of Technology, Box 1, PO Ingle Farm, SA 5098.

Hon. Treasurer: Mr F. C. Gillespie, Defence Standards Laboratory, GPO Box 1935P, Adelaide, SA 5001.

Fifth International Vacuum Congress

This will be held at the Sheraton-Boston Hotel, Boston, Massachusetts, USA, from Monday 11 October to Friday 15 October 1971. The programme will include both invited and contributed papers on original work in the fields of vacuum science and technology, including thin films and vacuum metallurgy. An International Conference on Solid Surfaces is being organized as an integral part of the Congress. An exhibit of vacuum equipment will be held in conjunction with the Congress. A second announcement, giving information on housing, further details of the entire Congress, and calling for the submission of abstracts for contributed papers before May 1971 was distributed in December 1970. The authors of abstracts which are accepted for presentation at the Congress will be required to submit a written paper for inclusion in the Proceedings of the Congress.

Inquiries regarding the Congress should be addressed to Miss Nancy Hammond, Executive Secretary, American Vacuum Society, 335 East 45th Street, New York, NY 10017, USA.

Summary of Papers Presented at Symposium: Part II


B. G. Baker and B. B. Johnson, School of Physical Sciences, The Flinders University of South Australia, Bedford Park, SA.

Nickel films have been deposited on Pyrex at various temperatures and on mica and rock salt. The bulk film structures have been determined by electron microscopy and the surface structures investigated by measuring photoelectric emission. The photocurrent, measured as a function of the wavelength of the incident light, is shown to be a sensitive indicator of surface structural heterogeneity.

For films deposited on Pyrex at above ambient temperature, the extent of the close-packed crystal planes can be determined and their identity established from the known work functions. Films deposited at low temperatures have extensive rough areas of low work function. These areas dominate the total photoemission and the surface structure cannot be resolved in this case. Such films, when annealed under ultrahigh vacuum conditions, gave photocemission results in agreement with other films deposited at the annealing temperature. Films deposited on mica and rock salt, although well epitaxed, were usually found to be not sufficiently homogeneous to permit the work function of the preferred surface orientation to be determined accurately.

The photoelectric measurement was also found to be a useful test of surface cleanliness. The films were deposited in small glass u.h.v. systems which held a vacuum of 10^-8 torr when closed off for prolonged periods. Nickel films were found to give reproducible photoelectric emission over periods in excess of one week. In other experiments, it was shown that these
measurements on nickel were sensitive to adsorption of small amounts of CO₂, CO, O₂, and CH₄. It is concluded that an evaporated film of large surface area can be maintained in a clean condition for prolonged periods provided the vacuum system is carefully prepared.

J. A. Ramsey, Department of Physics, The University of Newcastle, NSW.

The principles and techniques of Auger electron spectroscopy are briefly reviewed. The sensitivity of the technique to surface coverage of contaminants in the sub-monolayer region is discussed; included are some of the difficulties in quantitative interpretation. The discussion is related to the author's work on work-function changes on metal single crystals during adsorption, together with supporting LEED studies.

17. Variable Wavelength, Optical Interference Filters
J. Ward, Department of Supply, Mechanical and Optical Techniques Group, Weapons Research Establishment, Salisbury, SA.

Many experiments carried out by rockets and satellites have as their aim the analysis of radiation from heavenly objects, such as stars, to find the level of radiation received at all wavelengths in the spectrum of the object.

At WRE a method has been developed for making variable wavelength filters on glass discs, 6–10 inches in diameter, which will transmit a single, narrow wavelength band in any part of the spectrum according to the angle through which the filter is turned. The individual layers in a filter are deposited on a substrate, inside a vacuum chamber, in such a way that each of the layers varies uniformly in thickness according to its position on the disc, from a known thickness d at 0° to thickness 2d at 180°.

This variation of layer thickness is achieved by rotating a pair of metal masks at appropriate speeds between the rotating substrate and the evaporation sources during the deposition process. The design of masks and their relative speeds of rotation are carefully controlled to produce the required effect. A typical circular variable filter, made in this way, can scan linearly from 4000Å to 8000Å in the first 180° of rotation and back again to 4000Å in the remaining 180°. Other distributions can be produced.

18. Precise Pressure Measurement in the Range 0.1 Torr to 500 Torr
J. Gascoigne, Ion Diffusion Unit, Australian National University, PO Box 4, Canberra, ACT.

The requirement for measuring total gas pressures in the range 0.1 torr to 500 torr and above, of ultrapure gases is becoming increasingly important in several fields of work. To cater for this need, several commercial gauges have been developed over the last decade. Two of these gauges, a quartz spiral Bourdon tube, and a capacitance manometer are described, and their performance and limitations discussed.

A deadweight primary pressure standard, which has been used as a sub-standard for checking in the absolute accuracy of the instruments, is also described. It will be shown that although the quartz manometer lacks high resolution at pressures less than 4 torr, it is in general comparatively stable over long periods of time. By contrast, the capacitance manometer possesses extremely high resolution at low pressures, but appears to lack the long-term stability expected of this instrument.

19. Precision in Vacuum-Pressure Measurements and the Need for Simple Secondary Standards
J. W. Kelly, AAEC Research Establishment, Lucas Heights, NSW.

Although vacuum-pressure measurements now cover a range of 17 orders of magnitude, the accuracy of total gas-pressure measurements in primary standard devices cannot be guaranteed better than ±0.1 per cent in the range 760 to 10 torr, ±1 per cent to 10⁻² torr, ±10 per cent to 10⁻⁶ torr, and a larger and indeterminate value for the remainder of the range. Factors giving rise to these limitations are discussed with particular reference to measurements in the molecular-flow regime and it is suggested that a simple secondary-standard system could consist of a radioactive ionization gauge for the range 760 to 10⁻⁴ torr, a Schülz-Phelps gauge from 0.5 to 10⁻⁴ torr, and a Lafferty hot-cathode ionization gauge from 10⁻⁴ to 10⁻¹⁰ torr.

20. Gauges as Leak Detectors
W. Cole, Improved Cryogenic Products, PO Box 123, Coffs Harbour Jetty, NSW.

Summary not available.

21. An Application of Diffusion Bonding in the Construction of a Miniature Pressure Vessel
J. Budge (presented by Dr C. Edwards), Physics Department, University of Western Australia, Nedlands, WA.

The diffusion-of-bonding technique has been used to meet an exacting specification calling for the flux-free sealing of a shallow, disc-shaped pressure shell (0.022 in by 1.020 in diameter) whose component parts were machined as two separate pieces. The joint involved the simultaneous edgewise bonding of many annular bulkheads 0.005 in wide and, in the same operation, the fabrication of a pressure valve by sandwiching a thin flexible diaphragm between the valve features machined in each half of the vessel. Relative drift of the valve parts and buckling of the thin outer shell (0.005 in) of the container during bonding were prevented by careful design of the compression jig. Destructive testing of a trial joint and pressure testing (up to 100 atmospheres) of the finished vessel indicate that the strength of the multiple bond is of the order of that of the parent titanium.
22. Diffusion in and through Polymeric Materials
J. W. Kelly, AAEC Research Establishment, Lucas Heights, NSW.

The use of any solid material in a vacuum environment is governed both by the rate of diffusion into and through the solid and by the rate of sublimation. However, unlike metals, polymeric materials do not always obey the Knudsen-Langmuir equation for sublimation rates. In vacuum these materials can depolymerize by unravelling of the macromolecules into smaller volatile fragments of variable composition. This occurs throughout the bulk of the solid and so adds a complicated diffusion and solubility problem to the normal gas load due to gases diffusion through the material and the true sublimation loss.

Generally, the selection of these materials has been on an ad hoc basis by measurements of weight loss per unit time and ultimate vacuum attainable for a given pumping configuration. This paper discusses the effect of the glass transition temperature, molecular diameter, plasticizer context, crystallinity, and degree of cross-linking on the rate of diffusion and the extent to which knowledge of these parameters aids in the selection of such materials.

23. Mass Spectrometric Investigation of Gases in Glass
M. C. Simpson and B. W. Johnson, ACI Technical Centre, Dowling Street, Waterloo, NSW.

In the context of an overall study of factors influencing the refining of glass during the melting process, a study is being undertaken to characterize the gases existing in glass, in both the free state as bubbles or seed and combined with or dissolved in the glass. This study utilizes the high speed characteristics of the EAI Quad 250 Mass Spectrometer and an associated high vacuum sampling apparatus. This paper will discuss this application and the factors influencing the quantitative and qualitative measurement of the gases concerned. Previous work involving mass spectrometer analysis of gaseous inclusions in glass have suffered from considerable inaccuracies due to changes in gas composition, adsorption, and desorption effects during the lengthy time between bubble breaking and actual analysis, the limiting factor being the scanning speed of the mass spectrometer. It was thought that the use of a high-speed mass spectrometer, combined with direct exposure of the gas from the breaking bubble to the measuring head of the mass spectrometer, would overcome the problem of compositional changes prior to analysis.

Preliminary work has shown the effects adsorption and desorption can have, together with reaction and decomposition of gases by the hot filaments of the mass spectrometer ionizer unit and pressure gauge. This part of the study was conducted using artificially made gas bubbles containing known quantities of gas. From these results an analytical procedure has been developed which allows analysis of gas samples down to $10^{-4} \mu l$.

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**LETTER**

*Is the AIP of Use?*

**SIR,** I was interested to read, in the December, 1970 issue of *The Australian Physicist*, the report of the meeting of the ACT Branch at which was discussed the question ‘What is the hell is the use of the Institute of Physics?’

I strongly support the view that there is a need for a regular national meeting on all aspects of physics. It has always seemed to me that there is an almost total lack of a sense of community among Australian physicists. We are relatively small in number, widely dispersed, and far from the large research groups of North America and Europe. There is, I believe, an urgent need markedly to increase the interactions between groups and individuals in Australia in an effort partially to compensate for these factors. Clearly, the Institute as it is presently functioning does not provide a real national forum for physics in Australia.

Despite the problems of finance the Royal Australian Chemical Institute manages to hold a very successful biennial conference and, with support from industry, contrives to inject some international flavour into these conferences.

It is high time that the Council of the Institute of Physics gave this question further consideration. Perhaps it would be useful to ask all members of the Institute whether they would be interested in, say, participating in biennial conferences run along the general lines of the American Physical Society Annual Meetings.

Finally, I cannot resist letting Dr Aitchison know that the Institute’s letters after my name were of little use when I applied for my present job.

Professor of Physics, M. H. BRENNAN
Flinders University, Bedford Park, South Australia.
BOOK REVIEWS

MAGNETIC PROPERTIES OF OXIDES AND RELATED COMPOUNDS, Part a. Landolt-Börnstein, 
Numerical Data and Functional Relationships in Science and Technology, New Series, Group III— 
Crystal and Solid State Physics, Vol. 4 Editor-in-Chief K.-H. Hellwege. Springer-Verlag, Berlin, Heidelberg, 
Reviewed by L. G. Parry, School of Physics, University of New South Wales.

Volume 4, Part a is the revision of part of volume II/9 of the Sixth Edition of Landolt–Börnstein published in 1962. That edition aimed to cover material from papers published before mid 1960. This part of Volume 4 deals with iron and mixed iron oxides in section 1, compounds with lanthanide and actinide elements of some special structure types in section 2, perovskites in section 3, and yttrium and rare earth garnets in section 4. Each section is compiled by different authorities. Non-iron garnets, spinels and hexagonal ferrites, and a substance index are scheduled for Volume 4, Part b. In most sections an attempt has been made to collate material in papers up to the end of 1968, but in Section 4 papers by title are given for 1967, 1968. Occasionally 1969 references are also given.

As in the earlier edition, a great deal of information has been collected and it is doubtful if any significant contributions have been overlooked. The data are presented principally in tables and figures, the latter from cited original publications. A general introduction covers some of the background generalities for each section. A considerable amount of the material from the earlier edition is repeated so that the two parts of this volume will be self-contained. Much of the technically important information is scheduled for Part b, so that a complete coverage of the oxide properties will require access to both parts.

In Part a, text material is given in English and German and the tables and figures (of which there are some 500) are given with only English titles and explanation.

As a concise source of data and publications, the volume is excellent but, because of its comprehensive coverage, the cost of Part a makes it primarily an item for reference libraries, in which one would expect also to find Part b if it reaches a comparable standard.

York, 1969. xix + 226 pp. $17.35. 
Reviewed by B. H. J. McKellar, School of Physics, 
University of Sydney.

This book contains the invited papers given to a conference on \( \pi N \) scattering in 1967. They are excellent accounts of the state of the subject at that time, and it is therefore to be deplored that publication of this book took so long.

\( \pi N \) scattering is the most intensively studied reaction involving elementary particles. For this reason the experimental and theoretical study of it has played a central role in the development of the major concepts of particle physics, and it was indeed appropriate to devote a whole conference to this topic. The fashions of the present, notably duality, were in their infancy in 1967. Perhaps for this reason these lectures form a useful link between textbook accounts (such as the book by Cence, reviewed in the Australian Physicist, March 1970, p. 48) and the modern literature.

MATHEMATICS APPLIED TO PHYSICS, E. 
Roubine ed. Springer Verlag, Berlin, 1970. xvii 
Reviewed by R. W. James, Department of Applied 
Mathematics, University of Sydney.

Sponsored by Unesco, this book is the result of work by a dozen authors from seven different countries. Eight chapters are in English, two in French. The book presents in modern, pure-mathematical terminology an interesting and uncommon collection of topics as indicated by the following chapter titles: Functions of Complex Variables, Theory of Distributions, Exterior Differential Forms, Ordinary Differential Equations, Partial Differential Equations, Integral Equations, Numerical Solutions of Partial Differential Equations, Optimization, Probability Theory and Its Applications (to stochastic processes, harmonic analysis and information theory), and Quantum Mechanics (this last chapter being devoted to group representation theory).

Although intended for physicists, the book represents heavy reading for people with less than the equivalent of an honours degree in pure mathematics. Moreover, the book contains many printing errors—not all insignificant. For example, the Lorentz transformation and the Pauli spin matrices are given incorrectly. Such errors when combined with the sophisticated pure-mathematical jargon rule out use of the book for quick reliable references. More easily read versions (from a physicist's viewpoint) of the same topics are available elsewhere, although perhaps not in a single volume. The price is reasonable.

CLASSICAL DYNAMICS OF PARTICLES AND 
SYSTEMS (Second Edition), Jerry B. Marion. 
Reviewed by J. G. Collins, National Standards Laboratory, Sydney.

This is a very good book.

Professor Marion has written a text for a one-year, three-hour course in classical mechanics at 'advanced undergraduate level'. As such it would be suitable for the third year of an applied mathematics or theoretical physics course at an Australian university.

The opening chapter and the seven appendices contain mathematical background on vectors, tensors,
complex numbers, matrices, etc., most of which would be revision for a local undergraduate. The book then introduces Newtonian mechanics with emphasis on the conceptual aspects, progressing later to Lagrangian and Hamiltonian dynamics. Some six chapters are devoted to oscillatory phenomena: linear, non-linear, driven, and coupled oscillations; vibrations in strings; and the wave equation. (The extended treatment of oscillations is the principal change from the first edition of this book.) The calculus of variations, central forces, non-inertial frames of reference, and rigid-body dynamics are covered, and there are chapters on the peripheral topics of special relativity and two-particle collisions. Rather surprisingly for a book written with quantum mechanics in mind, there is no discussion of Poisson brackets or canonical transformations.

The book is less sophisticated and more expansive in its explanations than is the classic text by Goldstein. The writing is clear and uncomplicated. Each chapter has a set of useful problems and there is ample cross-referencing both of other mechanics texts and of historical sources. Here the author comes to grief with the style of the English peerage, listing J. W. Strutt, Baron Rayleigh, as J. W. S. Rayleigh—but perhaps this is petty carping at a book which is so well written and which I thoroughly recommend.


Reviewed by H. F. Pollard, The University of New South Wales.

'Fundamentals of Physics' is a somewhat shorter and more tightly written version of the familiar text by Halliday and Resnick. The new book has 40 chapters compared with 48 chapters in the full text, the supplementary topics have been omitted and so has much of the material that is in small type in the parent book. While teachers generally like to see extension topics and comments in small type, it is doubtful if students ever read these sections. It is difficult enough to persuade the average student to read any part of a textbook, let alone more sophisticated comments in small type. With the clear printing of text and illustrations the new book has a more attractive appearance than the earlier text. As before, an outstanding feature of the book is the frequent insertion of worked examples, many of which extend the basic ideas expounded in the text.

The tightening process has further improved an already excellent introduction to gravitation, there is a new and improved treatment of power and intensity in wave motion and a smoother introduction to electromagnetic waves. It is a pity that the pictorial introduction to 'Fields of Flow' has been omitted as this section forms an important introduction to field concepts. There is an over-abundant supply of questions and problems. It might have been more realistic to have printed three or four short sets of graded questions and problems at the end of each chapter. The effect would then be less overpowering on the student than the sight of around 20 questions and 40 problems for a single chapter.

Altogether the book contains a clear exposition of the elements of physics together with a copious supply of questions and problems from which to choose. As in the fuller text there are a number of useful appendices including an excellent set of conversion tables.


Reviewed by D. Haneman, School of Physics, University of N.S.W.

This volume consists of 18 invited papers given at the International Symposium on Electron and Nuclear Magnetic Resonance, held at Monash University in Melbourne, August 1969. A conference organized around measuring methods, rather than a particular area of investigation, is bound to cover broad fields. Thus the 18 papers here range over discussion of crystal defects, nematic liquids, magnetic alloys, glasses, rate processes, and many others. Twelve papers are on n.m.r. and six on e.p.r. Any scientist involved with resonance work will probably find at least a few papers of close interest, with many of the others of peripheral concern. Some have considerable review content e.g., n.m.r. studies of glasses and related solids (P. J. Bray), n.m.r. in non cubic metals (S. D. Mahanti, L. Terlîkê & T. P. Das), n.m.r. in rotating solids (E. R. Andrew), e.p.r. in dilute magnetic alloys (J. Dupras, B. Giovannini, R. Orbach, J. D. Riley, and J. Zitko), e.p.r. of electronic states of crystals (W. Hayes), while many contributions are mainly of research type.

The paper quality of the production is fair, with typewriter offset-style, left-hand line-up printing. One sometimes wonders whether it is in the best interests of the scientific community to publish conference proceedings in separate volumes, rather than in special journal issues, to which references are generally easier to find. Fortunately the editors in this case have provided an index, which makes the volume more than a collection of authoritative but not very related papers, and lends it more reference value.


Reviewed by J. S. Godfrey, CSIRO Division of Fisheries and Oceanography, Cronulla, NSW.

The lectures and reprints collected in this book describe some recently developed ways of dealing with differential equations that have wavelike solutions. The subject matter is very broad—the equations may be linear or non-linear, isotropic or anisotropic, homogeneous or inhomogeneous—and the contributors are oceanographers, general relativists, and pure mathematicians, each using their own notation. Not sur-
prisisingly, the book is hard to read. Nevertheless, any mathematical physicist who expects to deal with a 'non-standard' hyperbolic equation in the next few years will profit by studying the book.

Nearly half the papers were contributed by Lighthill's school of oceanographers; their notation will be clear to any physicist, but not all readers will have a physical intuition for the examples chosen. Lighthill describes how to find the waves radiated from a local forcing region for any homogeneous linear hyperbolic equation (i.e. how to put the small imaginary parts into the Green's function of an anisotropic equation). Much progress has also been made on the geometric optics of hyperbolic equations, stemming from Whitham's development of Lagrangian methods. When a wave-front encounters slowly-varying inhomogeneities, the conservation properties of certain 'adiabatic invariants' can be used to trace its progress; the method can be used for non-linear as well as linear systems, and some quite surprising predictions concerning finite-amplitude water waves have been made on this basis. Seven papers reprinted in this book are mainly devoted to elaborations of these two techniques. Some contributions by pure mathematicians will interest physicists—particularly Hersh's study of what boundary conditions are compatible with the 'hyperbolicity' of a given differential equation. Most other contributors use too much mathematical jargon, however. The reviewer is not competent to comment on the contributions of the relativists, beyond saying that the main contributor (A. H. Taub) writes well.


From the moment the first edition of this book appeared in 1951 it was an immediate success and it has become a standard introductory reference for those with a direct or indirect interest in flames. The fact that a third revised edition has now been published reflects the wide industrial importance of flames and the sustained fascination with their complexities. The present edition provides an up-to-date readable account of the physics of flames. The format remains as for the earlier editions but some pruning and revision has been made to permit inclusion of new material and in recognition of the appearance, since the second edition appeared in 1960, of a number of new books on specialized aspects of flames. There are chapters on the characteristics of pressurized flames, flow visualization and flame photography, the measurement of flame velocity, the structure of the reaction zone and its relation to flame propagation, diffusion flames, flame noise and flame oscillation, solid-carbon formation in flames, radiation processes in flames, flame temperatures, ionization in flames, and combustion processes of rocket-type fuels. The most extensive revisions are centred on noise and ionization in flames (Chapters VII and XIX).

The present edition will ensure this book will remain an up-to-date and authoritative introduction to the physical processes in flames. However, there is probably insufficient new material to entice anyone, already possessing the second edition, except the specialist and libraries, to add it to their collection. A minor criticism is the failure to mention (in Chapter XII which is concerned with the calculation of flame temperatures, or elsewhere) the critical and up-to-date compilation of thermochemical data that is available in the JANAF Tables. (Stull D. R., JANAF Thermophysical Tables, Clearinghouse, US Dept of Commerce, Springfield Va, 1965, and First Addendum PB 168370—1 Aug. 1966, Second Addendum PB 168370—2 Aug. 1967.)

SPRINGER TRACTS IN MODERN PHYSICS, Vol. 49, Electron Scattering, Photo Excitation, and Nuclear Models by H. Uberall; Baryon Current, Solving SU(3), and Charge—Current Algebra by H. Kleinert. Springer-Verlag, Heidelberg, Berlin, 1969. 146 pp. $11.00. Reviewed by B. M. Spier, School of Physics, University of Melbourne.

The two reviews making up this monograph are both written at the research worker level, the first in the area of nuclear physics and the second in particle physics.

The article by Professor Uberall reviews electron scattering, with a marked emphasis on inelastic processes. The discussion of such processes divides naturally into excitation of levels below the giant resonance, and excitation of the giant resonance itself. The excitation of the giant resonance is an important aspect of inelastic electron scattering for incident energies greater than 50 MeV. Thus, the review goes on to discuss theories of the giant resonance, the structure therein, and the influence of these theories on the interpretation of electron-scattering experiments.

The theoretical description of the baryon resonances, one of the continuing problems of particle physics, is discussed by Professor Kleinert in the second article. It is devoted to a particular group theoretical approach, using the dynamical group O(4, 2), which is shown to give the mass spectra of the observed baryon resonances and their electromagnetic properties. The approach does, however, raise several questions, and these are summarized in the last section. It would have been preferable for the article to be somewhat longer, and to include a more detailed discussion of the validity of the approach in the description of baryon properties.

This book would be an asset to research workers in either field; whether it is reasonable to expect an individual to purchase the book at the price for one article only is, however, open to some doubt. Certainly it has a place on the shelves of all physics libraries.

CORRECTION—Foundation of Physics, R. L. Lehman and C. Swartz. Holt, Rinehart and Winston (Australia) Pty Ltd have advised us that the price of this book is $6.95, not $8.80 as stated in the review, AP October 1970.
LECTURER
IN PHYSICS

Applicants should have a Doctorate or equivalent indications of research standing in physics or electrical engineering, several years post-doctoral activities or evidence of experimental research capabilities supported preferably by suitable publications. Overseas experience would be an advantage.

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