turn, stimulated activity in the field. In the latter half of the nineteenth century, the work of the great French physicists Amagat and Cailletet was associated with the problem of the liquefaction of the so-called 'permanent gases'. It was followed in the early years of this century by the pioneering work of Le Chatelier and Haber on the effect of pressure on chemical equilibria and, in particular, on the synthesis of ammonia. During the period 1912–60, P. W. Bridgman advanced the subject by greatly extending the range of pressure accessible for experimental observation and by measuring the physical properties of numerous liquids and solids up to pressures of several hundreds of thousands of atmospheres. The latest step forward has carried observations into the range of pressure found within the Earth and in astral bodies.

Since pressure is one of the thermodynamic functions which determine the state of a material system, its effects are not confined to any one branch of science. The literature is scattered and it is by no means easy to obtain a coherent picture of a subject which is advancing rapidly on many fronts. Workers in the field and students will, therefore, welcome a series of reviews, edited by R. S. Bradley, in which important aspects of recent work are summarized and accompanied by bibliographies. The scope of *High Pressure Physics and Chemistry* includes an account of the methods of generating and measuring high pressures, descriptions of apparatus and experimental techniques and the applications of pressure to the investigation of reaction rates, chemical equilibria, the physical properties of matter and the Earth sciences.

The discoveries which have aroused greatest interest in recent years are those resulting from the combined use of high temperatures and high static pressures, and those in which transient high dynamic pressures have been applied by shock-wave methods. In the former, a number of solid–solid transitions have been investigated, including boron nitride–borazon, silica–coesite and graphite–diamond, and also certain phase changes in metals which are presumed to involve an electron transition; this work is well summarized in two contributions by R. S. Bradley and W. Paul respectively. In the latter, electrical and metallurgical effects have been observed up to pressures as high as $10^6$ atmospheres and new $P$–$V$ data have been obtained over a similar range.

The theory and application of shock-waves are dealt with in some detail by G. E. Duvall and G. R. Fowles, and the problem of an equation of state applicable to ultra-high pressures by L. Knopoff. The development of shock-wave methods for determining equations of state allows direct comparisons of pressure–density relations to be made and is affording important information on the composition of the Earth's interior. Thus it has been shown that the density of iron is somewhat larger than the densities in the Earth's core and that a mean atomic number of about 23 is consistent with core conditions.

In giving a survey of the applications of high pressures to the Earth sciences, P. J. Wyllie points out that we are now passing through a period of reconnaissance—"a reconnaissance of possible processes that could lead to the formation of a particular assemblage of minerals with specific textural relationships"—and that this must be followed by a period in which more precise data are sought, particularly in the higher pressure–temperature ranges. The possibility which now exists of reproducing a geological process within a pressure vessel is opening up new fields in experimental petrology.

It would be wrong to conclude this review without a reference to contributions by B. F. Dodge and S. D. Hamann on the effect of pressure on chemical equilibria in gaseous and condensed systems and on reaction rates. The aim of the authors is a very practical one, that is, to provide a basis for calculating the conversion at equilibrium of a reactant, either in a single reaction or in a set of simultaneous reactions as it is influenced by pressure, predicting whether or not a proposed new reaction is thermodynamically possible and under what conditions of temperature and pressure it could be expected to give favourable yields, and determining the role of pressure on the rates of homogeneous liquid phase reactions.

Dr. Bradley has been fortunate in enlisting the co-operation of so many distinguished workers in the high-pressure field in the preparation of his book, and he is to be congratulated on the successful manner in which he has discharged the onerous duties of editor.

D. M. Newitt

## PLASMA PHYSICS

### The Theory of Plasma Waves

By Prof. T. H. Stix. Pp. x + 283. (McGraw-Hill Advanced Physics Monographs Series.) (New York and London: McGraw-Hill Book Company, Inc., 1962.) 76*s*.

THE theory of waves in a plasma may be said to have originated with the pioneering papers of Langmuir and Tonks in the late 'twenties. Interest in the subject was revived after the Second World War because of its importance in the problem of thermonuclear fusion—the 'philosopher's stone' of plasma physics. Since then a vast number of papers on the subject of plasma waves have appeared, but up to the present these lay scattered among the pages of many scientific journals. In this beautifully produced book the author had collected together as an organic whole the many complex topics connected with the behaviour of waves in plasmas contained in these papers. The book is a model of exposition and, in my opinion, a classic among the extensive literature on the physics of plasmas.

The book deals with small-amplitude waves in a cold plasma, boundary value problems in plasma waves, and the theory of waves in a hot plasma—both in the absence and in the presence of a magnetic field. In the first chapter the topological genus of the wave-normal surface is discussed and in the succeeding chapter the small amplitude waves are analysed more fully in terms of the now well-known diagram due to Clemmow, Mullaby and Allis. Here will be found derived in a logical sequence the hydromagnetic waves of Alfvén and Aström, ion-cyclotron waves, the Appleton–Hartree dispersion relation and the so-called 'electrostatic waves'.

The flow of energy associated with the passage of plasma waves is discussed here and such concepts as group velocity and ray optics are admirably treated. The author also introduces the notion of 'accessibility' in a plasma of high density.

Problems of stability of equilibrium plasma configurations associated with the names of Kruskal and Schwarzschild are regarded as boundary value problems in plasma waves—though the classical methods of Kruskal and Schwarzschild are faithfully followed.

An interesting account is given of the plasma models with discrete structure and especially those due to Dawson and van Kempen, and also of the 'trapping' of charged particles in the potential wells of the electric field of the plasma waves. Mention is also made of the important work of Bunemann of two-stream instability using a charged-sheet model of a plasma.

The major portion of the book is concerned with a 'hot' plasma; there are clear expositions of the physical nature of Landau damping, that is, the phenomenon of the absorption of energy from a plasma by a collisionless process, and of the Nyquist criterion for instability. A chapter devoted to the theory of small amplitude waves in a hot plasma in the presence of a magnetic field includes such topics as cyclotron damping, magnetic trapped particle modes, concluding with a discussion of the solution of Boltzmann's equation for a hot plasma. This covers damped, stable and undamped waves. In the final chapter, the author considers the propagation

of waves in the case where both the plasma density and magnetic field are inhomogeneous with the associated phenomenon of reflexion and absorption of these waves in certain critical cases.

An interesting feature of the book is the admirable collection of examples (of which there are nearly one hundred) at the end of each chapter. Some contain hints for the proof of theorems enunciated in the text, others serve as useful illustrations of points discussed therein. There is also a comprehensive bibliography. The author is to be congratulated on this excellent treatise, and every plasma physicist will feel indebted to him for this. It will surely find a place on the library shelves of every serious student of plasma physics.

V. C. A. FERRARO

## SOLVING FIELD PROBLEMS

### Analysis and Computation of Electric and Magnetic Field Problems

By K. J. Binns and P. J. Lawrenson. Pp. xiv+333. (London and New York: Pergamon Press, 1963.) 84*s*. net.

FREQUENTLY an engineer or physicist has to solve a field problem involving complex mathematical analysis. More often than not it is difficult to find someone who can understand the problem and advise on the best way of solving it. Although the situation is improving it is still a rare department that has a highly competent engineer–mathematician on its staff who can advise others on the best methods for tackling specific problems.

This book goes a long way towards providing many of the answers that are required. It is directed at practising engineers and physicists, as well as students seeking a better understanding of field problems. The standard of mathematics required to start reading the book is within the syllabus of a normal engineering degree; where more advanced mathematical topics are introduced, they are fully explained in the text. Throughout the book the emphasis is on the physical significance of the mathematics, and to this end practical examples are used wherever possible.

The book is divided into four parts. Part 1 serves as an introduction to the rest of the book; it deals with basic field theory and the methods of calculating force, inductance and capacitance from a knowledge of the field distribution. Part 2 is concerned with images and direct methods of solution, much along the lines of the book by Hague. However, in addition, attention is directed to the solution of the Laplace equation in Cartesian coordinates, and where the method of images is used the solutions are expressed in a convenient complex variable form.

The largest part of the book, Part 3, deals with transformation methods, and the authors claim that their treatment of the subject is the most comprehensive available. This certainly appears to be so, for in the five chapters in this part the authors present in a most clear and concise fashion a vast amount of transformation theory. The first chapter in this section presents the basic transformation theory leading up to the transformation equations. The second chapter is concerned with curved boundaries and the following chapter with polygonal boundaries. There follows a chapter on the application of elliptic functions and finally one on general considerations. Of particular interest in this third part are the treatments of line and doublet sources, the transformation of regions exterior to finite polygonal boundaries and a most useful technique for the direct numerical integration of functions of a complex variable, which permits solution of problems involving boundaries of greater complexity than is otherwise possible.

In Part 4, the powerful finite-difference methods are discussed. Again, the treatment is from first principles, and practical problems serve as examples for the application of the techniques evolved. The practical advice on the actual methods to be adopted is most useful. The section devoted to convergence and the optimum choice of parameters to provide the most rapid convergence possible for any given problem is probably the best so far available anywhere in the literature. Other topics include gradient boundary conditions and errors. In the conclusion to this part, the authors make the point that if a digital computer were used, it might be possible to reach the solution to a problem much more quickly by means of finite-difference methods than by analytical methods—that is, if an analytical solution exists anyway.

The appendixes include a useful list of transformations, many of which have not previously been published. These, for the most part, involve elliptic functions.

Every chapter ends with two lists of references. The first refers to specific points in the text, and the second indicates related literature which could be of interest. In addition, at the end of the book, an extensive bibliography is included.

Even if one knows a method for solving a specific problem one would be well advised to look within the covers of this book to ensure that no better method exists for the solution. This is an excellent volume, which is certain to prove most popular. The authors are to be congratulated.

E. M. FREEMAN

## PHOTOCHEMISTRY

### Advances in Photochemistry

Vol. 1. Edited by W. Albert Noyes, jun., George S. Hammond and J. N. Pitts, jun. Pp. ix+443. (New York and London: Interscience Publishers, a division of John Wiley and Sons, 1963.) 125*s*.

DURING the past few years, there has been a rapid rise in the number of *Progress in . . .*, *Advances in . . .*, *Aspects of . . .*, and other such series about various topics in chemistry. As a result, with any new series of this general type, the reviewer must not only consider the merits of the particular volume being discussed, but also whether the series itself fulfils any real need.

The growth of virtually all aspects of photochemistry has been particularly marked during the past fifteen years. This has undoubtedly been as much due to the development of new analytical techniques (for example, gas chromatography) as to developments in spectrometers and progress in spectroscopy generally. Considerable advances have been made in the elucidation of mechanisms of many photochemical reactions and progress has also been made in determining the nature of the intermediate excited states resulting after the absorptions of radiation. A surprising number of compounds obtainable only with extreme difficulty by conventional synthetic procedures can now be made simply by photochemical methods, and often on quite a reasonable scale. Indeed, the first really large-scale manufacture of materials using a photochemical reaction has recently been undertaken.

Few of these developments have yet appeared in chemical text-books, and surprisingly few works specifically devoted to photochemistry exist. While several reviews and articles on various photochemical topics have been published, they are very widely scattered. Thus we see that there is little doubt of the real need of a series of reviews on photochemistry.

Volume 1 of *Advances in Photochemistry* consists of nine chapters, and contains, in addition, author and subject indexes. The first chapter on "The 'Vocabulary' of Photochemistry", by J. N. Pitts, jun., F. Wilkinson and G. S. Hammond, deserves to be read not only by all practising and intending photochemists but also by