

Reviews of Books

Croissance de Composés Minéraux Monocristallins. Ed. J. P. SUCHET. (Masson et Cie, Paris, 1969). Pp. 170. Price 55 F.

This volume is mainly concerned with the growth of high-purity single crystals of a number of materials which are of interest in connection with lasers, ferroelectrics and magnetic properties. Some physical properties are also described. The book is in the form of a collection of papers given during a seminar on the chemistry of the solid state. It is in fact the second in a series, and took place in the winter 1967-1968. The seminars were given by experts in both theoretical and experimental solid state physics and chemistry, and the book also includes the discussions that took place after the seminars. The topics considered include the mechanisms of the growth of molecular crystals, growth from solution, hydrothermal growth, growth of crystals such as Yag at high temperatures, and vapour phase growth.

There is a good balance between theory and experiment, and the book will be of interest to those concerned with crystal growth.

A. D. YOFFE

Received 31st July, 1969

Elementary Quantum Mechanics. By MORTEN SCHARFF. (John Wiley and Sons, London, New York Sydney and Toronto, 1969). Pp. viii and 213. Price 42s.

Undergraduate textbooks on quantum mechanics do not usually play an important part in developing the teaching of the subject. This is done by the definitive works of Landau and Lifshitz, Messiah, and Schiff. Undergraduate books tend to be selections from these works; different selections give different textbooks. This book is an exception. Although the material is familiar enough, its presentation and treatment are often original, and always lucid and penetrating.

The first chapter is an unusually good introduction to Schrodinger's equation, wave packets, uncertainty relations, and momentum and energy operators. The longest chapter (59 pages) is concerned with the time-dependent behaviour of particles, the shortest (34 pages) deals mainly with the stationary states of systems with several particles. The stationary states of a single particle in various potential fields (including the central field) are treated in the other two chapters. Crucial problems like the determination of stationary states, and the treatment of particle scattering, and crucial concepts like energy bands in solids, and the lifetimes and level widths of quasi-stationary states are all illustrated with simple one-dimensional models. Approximate methods for stationary problems (perturbation theory, and the variation method) are dealt with only briefly, and there are no applications to molecular forces or to molecular binding. Consequently this is a book for physicists; it is not likely to be used in an undergraduate course in a chemistry department of any British University. But it is an excellent introduction to quantum mechanics, and anyone engaged in teaching the subject should read it.

T. B. GRIMLEY

Received 6th August, 1969

Modern Methods for the Separation of Rarer Metal Ions. By JOHANN KORKISCH. (Pergamon Press Ltd., Oxford, London, New York and Paris, 1969.) Pp. xii+620. Price £7 10s.

This book describes methods for the separation of more than fifty elements using the methods of ion exchange, chromatography, liquid-liquid extraction, distillation and co-precipitation. The book begins with a short survey of the principles of modern separation techniques. The succeeding chapters are devoted exclusively to the separation of the various elements. All the old troublesome combinations are here e.g. zirconium and hafnium, niobium and tantalum, molybdenum and tungsten, technetium and rhenium, the rarer alkali metals, the rare earth elements and the actinides. The author, who has himself made some considerable contribution to the subject, has obviously made an exhaustive study of the literature and has collected together the most useful of the available information. The wealth of literature in this area is enormous and a major decision had to be reached to prevent the book getting completely out of hand. Hence detailed working procedures have had to be

omitted so that coverage could be complete. Nevertheless the most important suitable techniques are summarized at the beginning of each section.

This is an excellent book containing information never collected together before; it should prove of great value not only to those concerned with the analysis and separation of the less common metals, but to all those concerned with analysis in all its aspects.

R. BELCHER

Received 11th August, 1969

Advances in Photochemistry. Vol. 5. Ed. W. A. NOYES, Jr., G. S. HAMMOND and J. N. PITTS, Jr. (John Wiley and Sons, New York, London and Sydney, 1968). Pp. ix+400. Price 160s.

The first volume of this well-known series appeared in December, 1963; and now, in less than five years, we are at vol. 5. The series maintains its impetus, partly because of the enthusiasm of the three editors, partly because of the wise choice of contributors, and partly because a great number of scientists (drawn from diverse fields) are interested in the answers that can be given to the question "What is the detailed history of a molecule which absorbs radiation?"

Vol. 5 comprises four articles and a cumulative title index covering all five of the volumes published thus far. The first of the four articles is by Herzberg, on The Spectra and Structures of Triatomic Free Radicals. The only trouble is that the contribution (17 pages) is much too short. The work carried out at Ottawa in the last two decades has constituted such a major advance in our knowledge of the electronic spectra of small, polyatomic free radicals and molecules, that one would have liked to see an expanded account—though it must not be forgotten that Herzberg has published his own book on the subject. The second of the four articles is by P. J. Wagner and G. S. Hammond, on Properties and Reactions of Organic Molecules in their Triplet States. This is a subject on which there have been a great many publications in the last few years. No less than 513 references, mostly from the nineteen sixties, are cited by the present authors. A review is most welcome, and the length (135 pages) fully justified. J. Heicklen and N. Cohen contribute the third article, on The Role of Nitric Oxide in Photochemistry. As the 464 cited references reflect, this is an old subject whose study goes back at least half a century; but the last ten years have seen much progress in understanding the problems involved, and again an up-to-date review is most welcome. The last of the four articles is a comparatively short one (34 pages), by D. Phillips, J. Lemaire, C. S. Burton and J. W. Noyes, Jr. It is a thought-provoking discussion of the possible importance in photochemical systems of isomerization as a route for radiationless transitions; which is an idea that may well turn out to be much more widely applicable than hitherto realized.

Altogether, this is a most valuable volume.

A. D. WALSH

Received 12th August, 1969

Advances in Physical Organic Chemistry. Vol. 7. Ed. V. GOLD. (Academic Press, London 1969.) Pp. x and 351. Price 90s.

This volume continues the excellent standard of interest and presentation already established in this series. The two most substantial articles are those on Nucleophilic Vinylic Substitution (Z. Rappoport) and Protolytic Processes in H_2O - D_2O Mixtures (V. Gold), each of which gives a full and well-documented account of the subject. Of the other articles, Structure and Mechanism in Carbene Chemistry (D. Bethell) and The Reactions of Hydrated Electrons with Organic Compounds (M. Anbar), both relate to fields in which many reviews have been published, but because of the rapid development of their subjects both articles contain much new and interesting material. Finally, Meisenheimer Complexes (M. R. Crampton) deals with a special class of compound which has been known since the turn of the century, but only recently re-investigated by modern techniques.

R. P. BELL

Received 13th August, 1969

The Virial Coefficients of Gases—A Critical Compilation. By J. H. DYMOND and E. B. SMITH. (Clarendon Press: Oxford University Press, Oxford 1969.) Pp. xv and 231. Price 45s.

This book lists values of the second and third virial coefficients of pure substances which are available in the literature and which have been derived from experimental measurements (almost exclusively from *PVT* work). Some 200 substances are covered and the survey includes references up to

early 1968. No mixture properties are covered in this edition, although they are promised in a later one.

The quality of a book of this type can be judged by means of three criteria. (i) Accuracy of transcription from the original publication. Here the authors have been very successful. Spot checks on about 5% of the tabular matter produced only one serious error—the wrong sign for C in table No. 4 on pg 86 for 2-propanol. (ii) Comprehensiveness of the literature survey. Omissions of references which merely duplicate other entries in the compilation were noted but such omissions are in any case relatively unimportant. More serious would be omissions which limit the scope of the temperature range covered by the tables for a particular substance. Only two such omissions were found: the work of Lecocq and Saurel (on argon and nitrogen respectively) which extend the temperature range covered to 1100 K in each case. (iii) The comments and discussion provided by the authors. The authors are to be commended for estimating accuracies where none was given in the original reference and for discussing the relative merits where overlapping measurements exist. Both have been carried out with care. Invaluable also are the tables of smoothed values given for the rare gases, the common diatomic gases, the straight chain hydrocarbons up to C_6 and a few others such as benzene and chloroform.

In all, this is an invaluable reference book for all who use virial coefficient values, particularly those working in the field of intermolecular forces or on liquid-vapour equilibria. The book is paperback and very reasonably priced.

G. SAVILLE

Received 13th August, 1969

Thermal Conductivity: Proceedings of the Eighth Conference. Ed. C. Y. HO and R. E. TAYLOR. (Plenum Press, New York, 1969.) Pp. xx and 169. Price (U.S.) \$40.

Since 1961, nine of these Conferences on Thermal Conductivity have been held. The proceedings of earlier conferences were not formally edited or published until the Seventh (which was published by the National Bureau of Standards at \$6.25), so that the present volume is not a member of a continuous series of printed records. It contains material presented at the Eighth Conference, held at Purdue University, Indiana, in October 1968. The Contents section lists 112 papers, and an Appendix airs a suggestion for naming the S.I. unit of thermal conductivity. This Appendix scrupulously presents verbatim responses, mainly critical, of the proposal for a new trivial name and wisely decides to go no further.

The principal fields discussed at the conference are: metals and alloys at low, intermediate and high temperatures; gases and mixtures of gases; molten metals and alloys; organic liquids; insulators and semi-conductors; fibres polymers, and some multicomponent systems. The papers are principally on thermal conductivity but a substantial fraction concerned with thermal diffusivity is included. Descriptions of apparatus for measuring thermal conductivity, thermal diffusivity and thermal contact conductance are particularly noteworthy. The activity of the host institution is reflected in the dozen papers contributed by its members. Discussions of the papers are not printed.

The distribution of authors is international and the variety of interests is great. Apparently at one extreme are the expositors of rigorous theory of heat transport in dilute gases or phonon interactions in idealized lattices while at the other are the makers of nose cones for rockets and the students of heat transfer in living matter. This conference and this volume do something to bring them together and present current activity in a variety of related fields in a single collection.

On the debit side is the fact that more than one third (39) of the papers presented are available in this volume as abstracts only; the remainder (73) are presented in full and the fact that some of them are too brief for critical appraisal reflects only their authors' predilections. The volume is well produced, up-to-date, broad and interesting, though it is not indispensable and librarians of specialized institutions and other prospective purchasers should check the contents to see whether what they hope to read in full is available only in outline.

P. GRAY

Received 18th August, 1969

Chemical Applications of Spectroscopy. 2nd Ed., Part 1. Ed. W. WEST. (John Wiley and Sons, New York, London, Sydney and Toronto, 1969.) Pp. x and 486. Price 160s.

This is Part 1 of the second edition of vol. IX in the series *Technique of Organic Chemistry* being published under the general editorship of A. Weissberger. Vol. IX is under the particular editorship of W. West. The first edition appeared in 1956. Since then, the enormous growth in the use by

organic chemists of spectroscopic techniques has necessitated the complete re-writing of vol. IX and its division into several Parts. Thus, Microwave Spectroscopy, and Infra-red and Raman Spectroscopy, are to have Parts to themselves; while another, new, Part is to be devoted to Electron and Nuclear Resonance Phenomena. Part I now consists of four Chapters, whose headings and authors are (I) Introductory Survey of Molecular Spectra by W. West; (II) General Theory of Electronic Spectra by A. B. F. Duncan; (III) Interpretation of Electronic Absorption Spectra by F. A. Matsen, R. S. Becker and D. R. Scott; (IV) Fluorescence and Phosphorescence Spectroscopy by R. S. Becker. Thus the book is now devoted essentially to the electronic absorption and emission spectra of organic compounds.

Chap. I and II, taken together, constitute an admirable introduction to spectroscopic theory. Parts of chap. III tread again some of the ground covered in chap. I and II. However, this may not be a bad thing for a reader who is trying to grasp the essentials of, e.g., group theory which is so fundamentally important to spectroscopy; it is often helpful, especially where familiarity with the symbols used is required, to read the same thing over again though in somewhat different language. Chap. IV deals with fields in which there has been much activity in recent years; an authoritative review is timely.

A few misspellings of authors' names ("Poppo" for "Pople", "Teagan" for "Teegan", "Buraway" for "Burawoy") were noticed, but one must hasten to pay tribute to the first-rate production of the book as a whole.

A. D. WALSH

Received 19th August, 1969

Halides of the Second and Third Row Transition Elements. By J. H. CANTERFORD and R. COLTON. Pp. xx+409. Price 120s.

Halides of the Lanthanides and Actinides. By D. BROWN. (John Wiley and Sons, London, New York, Sydney 1968.) Pp. x+280. Price 84s.

With the oxides, the halides of the elements are the cornerstones upon which preparative and physical inorganic chemistry are built. Most preparations in inorganic chemistry involve the use of halides and any correlation of structure or physical properties will almost certainly include them. These two volumes provide most of the information necessary for any chemist seeking to work with halides of the second or third row transition elements or of the lanthanides or actinides.

Both volumes start with a general survey which seeks to put the field into perspective. Both are good and the level of discussion is that which would be appropriate at an Honours degree level; these chapters would be very appropriate for reading by undergraduates or for the preparation of a course of lectures. Thereafter, the approach of the two volumes is different. In dealing with the second and third row elements, Canterford and Colton consider each vertical group separately whilst Brown, in dealing with the lanthanides and actinides, considers fluorides, chlorides, bromides and iodides separately. The approach by Brown emphasizes the need for a good index—that provided is adequate—whilst it is probably easier to find one's way around Colton and Canterford by rule of thumb. I personally favour the Brown approach—there is as much similarity between niobium (V) and molybdenum (V) as between molybdenum (V) and tungsten (V) and the approach emphasizes trends in the transition metals.

As the halides impinge so widely on all of chemistry the temptation must have existed to include almost everything. Any complex containing a metal-halide bond—or even an ionic halide—could qualify for inclusion in these books. This tendency has been resisted and the cover is reasonable, although each volume naturally reflects the interests of its authors. The authors have resisted the modern tendency to spend at least twice the space on theoretical interpretations of physical methods as on the results of the measurements. Because of this, their discussions will be of more lasting value than many currently written reviews. I thought that the discussion and cover of thermodynamic data rather sparse in Canterford and Colton and throughout this volume spectroscopic and magnetic studies are mentioned only very briefly. The cover is very up-to-date and fairly critical—again Brown scores slightly in this aspect.

Both of these books will be extremely valuable for all workers in inorganic chemistry. The chief uses will be to chemists who wish information on how to prepare halides and on the physical studies that have been made on particular compounds, but they will also be of use to undergraduates who need a general text on the broad properties of the transition elements. They are good value for money and there is no source which would easily provide all of the data collected together in these books.

D. W. A. SHARP

Received 19th August, 1969

Biophysique, Tome I, Énergétique, Cinétique, Isotopes. By J. TONNELAT. (Masson et Cie, Paris 1968). Pp. viii and 402. Price 80 F.

This book has been based upon a course of lectures given during the past six years by the author in the Faculté des Sciences de Paris, and has been arranged to meet the requirements of the recent (1967) revision of the curricula in structural and metabolic biochemistry (Tome I) and in physico-chemical and molecular biology (Tome II).

The volume under review contains three sections: energetics and their application to the fundamental phenomena of metabolism, chemical kinetics and their application to enzymology, and a single chapter on the properties of isotopes useful in biochemistry. There is an appendix on mathematical methods.

The author acknowledges a number of books as principal sources, including many well-known texts in English. Thus chapter 13, Kinetic Aspects of Enzymic Catalysis seems mainly to be derived from *Enzymes* by M. Dixon and E. C. Webb, and *The Chemical Kinetics of Enzyme Action* by K. J. Laidler. The book is a comprehensive text-book of physical biochemistry suitable for undergraduate biochemistry use, and also as a guide to the more quantitative aspects of biochemistry for research workers with limited experience of such methods. It fills a gap between some of the more elementary texts on physical chemistry for biologists or biochemists, and the standard works of reference which present specialized aspects of the subject. The style of the author is lucid, the diagrams and presentation are excellent, and the index and bibliography are convenient and accurate. It is a text-book which could confidently be recommended to a student having a moderate reading knowledge of French.

A. COUPER

Received 25th August, 1969

The Chemistry of Sulphides. Ed. A. V. TOBOLSKY, A. GUNNING, and E. T. KAISER. (Interscience Publishers, New York, London, Sydney, 1968.) Pp. xii+279. Price 125s.

I am sorry to have to review this book unfavourably in view of the effort that has been put into it. In it are some of the papers delivered at a conference on sulphur chemistry held at Princeton University in 1966. The fields considered were fundamental chemistry, sulphur-containing polymers (including the effects of sulphur compounds on rubber), and sulphur compounds in biological systems. The title is thus somewhat misleading and no ionic sulphides are considered. The contents of the book cover papers delivered at the symposium, but from the preface it appears that some of the papers on the biological systems were not available. They range from reviews of a fairly limited area to specialized research papers. As such, I am sure that all of the papers were much appreciated by those attending the meeting, but I am very doubtful as to whether it is necessary to collect them together and republish them in a book of the present kind, as presumably all of the new results will be published elsewhere with full details and the reviews are not in general long enough to provide definitive cover of a field. It is an expensive book and I cannot think that it will be necessary in many libraries or research laboratories.

D. W. A. SHARP

Received 25th August, 1969

Physics of Color Centers. Ed. W. BEALL FOWLER. (Academic Press, New York & London, 1968.) Pp. 655. Price 228s. 8d.

The intensive development of solid state physics post-1945 has included a study of the details of *F*-centres and a whole alphabet of other colour centres. After the initial wave mechanical exposition in the classics by Seitz and Mott and Gurney, there have followed extensive works using e.s.r. and other new experimental methods and corresponding developments on the theoretical side. The results of all this activity are summarized in this present beautifully produced work, which is concerned entirely with inorganic crystals. The chapter headings and authorship well indicate the coverage and high quality of the contributions.

1. Electronic Excitations of Perfect Alkali Halide Crystals by R. S. Knox and K. J. Teegarden. 2. Electronic States and Optical Transitions of Colour Centers by W. Beall Fowler. 3. F_A -Centers in alkali Halide Crystals, by F. Lüty. 4. Laser Spectroscopy by H. Mahr. 5. Zero-Phonon Transitions by D. B. Fitchen. 6. Moments and Degeneracy in Optical Spectra by Charles H. Henry and Charles P. Slichter. 7. Localized Modes and Resonance States in Alkali Halides by Miles V. Klein. 8. ESR and ENDOR Spectroscopy of Color Centers in Alkali Halide Crystals by H. Seidel and H. C. Wolf.

There are also two appendices listing bulk characteristics and optical data for the twenty alkali halides.

There is a great deal in this book to interest the general physical chemist, in the molecular species formed by irradiation of crystals and identifiable by e.s.r. It is probable that the book will also be of value to those involved in teaching courses of chemical spectroscopy. It will provide inspiration to those who, like the reviewer, are trying to make progress with the organic solid state.

D. D. ELEY

Received 25th August, 1969

Chemical Evolution. Molecular Evolution Towards the Origin of Living Systems on the Earth and Elsewhere. By MELVIN CALVIN. (Oxford University Press, 1969.) Pp. 278. Price 55s. net (paper cover 25s.).

This is the kind of compulsive reading that cannot be put down until completed. Written in a cursive conversational style (it was transcribed from a tape) it gets across Prof. Calvin's personal enthusiasm for his subject and his all embracing interest in the physical and biological sciences. Starting from molecular palaeontology, identifying the hydrocarbons in rocks by gas chromatography—mass spectrometry, Calvin reviews the experimental work on synthesis of amino acids and other monomers by electric discharges and similar energy sources and successively outlines what is known, or speculated, about the synthesis of biological macromolecules, organelles and membranes. A final short chapter, to which Mrs. Calvin has contributed, is entitled *The Search for Significance* and there is an appendix dealing with the possibilities of interstellar communication. For the research worker, the book is a mine of suggestions for further work. I believe also this book could be read at the other extreme by keen youngsters awaiting university entrance to give them a glimpse of the philosophical implications of scientific studies, in our age, where education is dominated by economic goals. It is well-produced and there are a large number of excellent diagrams and plates, but surely this is the first time the Oxford Press have ever printed the same figure twice in one book (Fig. 3.9 and 4.19)? One has the impression that that august institution has moved at unprecedented speed to publish this book before the lunar landings. In these circumstances, even Homer must be allowed a nod.

D. D. ELEY

Received 25th August, 1969

Helium-3 and Helium-4. By W. E. KELLER. (Plenum Press, New York, 1969.) Pp. xi+431. Price \$18.50.

There appears to be no end to the surprises to be revealed by the study of the properties of liquid and solid helium. Their main abnormalities were, of course, discovered before 1940, but in the last few years we have seen the proliferation of "sounds", the finding of minima in the pressures along the melting-lines, the logarithmic singularity of C_p on the lambda-line, and the discovery that not only are liquid helium-3 and helium-4 immiscible, but that the phase diagram is of extraordinary complexity and includes an apparent violation of the third law. These are a few of the topics that Dr. Keller selects for discussion in this new monograph. He admits that his choice is based on his own interests, but it is not an unbalanced one and reflects well the trend of much recent research.

The book can be recommended as a clear and up-to-date account of what he aptly calls "the astonishing physics of quantum phenomena on a macroscopic scale".

J. S. ROWLINSON

Received 2nd September, 1969

Reaction Mechanisms in Organic Chemistry. Monograph 8. Aromatic Nucleophilic Substitution. By J. MILLER. (Elsevier Publishing Company, Amsterdam, London, New York, 1968.) Pp. xi and 408. Price 155s.

Nucleophilic substitution in aromatic systems is an attractive system for quantitative study. In many cases it is possible to measure not only reaction rates but also equilibrium constants for the formation of addition products (so-called Meisenheimer complexes and related compounds) which are probably intermediates in many of the reactions. In these structures, aromaticity is lost and the factors which control their stability have been the subject of model calculations. More recently there has also been considerable interest in the alternative ("benzyne") mechanism in which elimination precedes addition.

Dr. Miller has now contributed a valuable review and compilation of these reactions. Showing evidence of having been written singlehanded over a number of years and therefore understandably uneven in treatment, it nevertheless conveys the enthusiasm and sincerity of one personally involved in the issues discussed and really caring about them. Fellow-enthusiasts will enjoy this style and itch to join the fray. Others may possibly think that the personal involvement is too great. For example, as early as p. 11, the author points out the reasons for the superiority of some of his own calculations of stability of complexes over those of a Japanese author, taking it for granted that the reader would already be familiar with the assumptions made in both treatments. Perhaps the example conveys some of the distinctive flavour of this book and its likely appeal to different classes of readers.

It is difficult to justify the high price.

V. GOLD

Received 3rd September, 1969

Physics of Solids in Intense Magnetic Fields. Ed. E. D. HAIDEMENAKIS. (Plenum Press, New York, 1969.) Pp. xx + 483. \$27.50.

This book gives the twenty-five lectures delivered at the first Chania Conference held in Crete during July 1967. Reading the list of distinguished physicists who presented the papers and led the discussions it is clear that the sunshine was not the only attraction for those participating. The chapters are clearly written and many of the results presented were new. The experiments described were made in magnetic fields which reached values of 230 kOe using Bitter type solenoids, and 20 MOe when explosive techniques were used.

The phenomena discussed will perhaps be of more direct interest to solid state physicists. However, the chapters dealing with magneto-optical effects of semiconductors such as the lead chalcogenides, the use of gas lasers in high-resolution magneto spectroscopy, quantum magneto-optics, modulation techniques for band structure studies, Faraday rotation, the Zeeman effect in crystals, and the Schubnikov de Haas effect in semiconductors, should be read by those investigators with a more chemical bias.

It is a pity the book has taken two years to print, otherwise there can be little criticism. The chapters have been written in a masterly way and the standard is extremely high. The publishers can be congratulated on bringing out a fine book.

A. YOFFE

Received 19th September, 1969

Thermal Radiation Phenomena. Vol. 1 and 2. Ed. K. M. LANDSHOFF and J. L. MAGEE. (IFI/Plenum—New York and Washington, 1969.) Pp. xvi and xvi, and 648 and 288. Price \$28 and \$14.

The research, the results of which are compiled in these books, was supported by various agencies of the United States Defense Department and Atomic Energy Commission. The object was to understand the behaviour of hot air in nuclear fireballs let off in the Earth's atmosphere. The computation takes into account a wide range of collisional and radiative processes and much of the material is consequently of general scientific interest, especially that of vol. 2. The research is also directly related to vehicle reentry.

Vol. 1 is devoted to the calculation of the absorption of air, as a function of wavelength and temperature. In the first 50 pages the subject is briefly introduced with a discussion of absolute transition rates and different processes of light absorption, including the photoionization of negative ions. The other 600 pages are a presentation of the data in the form of tables and graphs. The work is almost entirely a computation from existing thermodynamic and kinetic data.

Vol. 2 is rather different, being comprised of 10 somewhat independent chapters contributed by various authors. The main themes are excitation and non-equilibrium phenomena in air. Under excitation is considered effects of electrons, X and γ -rays, and heavy particles. Non-equilibrium effects include those due to secondary electrons, loss of light quanta by fluorescence, and chemical reaction. The final chapters describe models for the recombination and cooling in air plasmas. The full problem is one of extreme complexity.

The entire work seems to have been conducted with care and precision, and is nicely presented.

A. B. CALLEAR

Received 22nd September, 1969