BOOK REVIEWS

Nuclear Physics, Springer Tracts in Modern Physics 71,

The book consists of three review articles two of which are on muon capture by nuclei, and the third one is on the two and three body problem.

The first article deals with the Study of Nuclear Structure by Muon Capture. The author, H. Uberall, has the distinction of contributing very largely to the development of this area of interest. In a brief span of 38 pages the author has commendably presented a very comprehensive list of experimental and theoretical results. The first piece of experimental data is the total muon capture rate, and the existing theories, their difficulties and shortcomings have been briefly summarised in the beginning. The muon capture in nuclei is most often followed by neutron emission which may come from the direct process in which a proton in the nucleus absorbs the negative muon and gets converted to a neutron and emits a mu-neutrino; the neutron may also come from a two-step process where the first step is the formation of an excited nucleus above the particle threshold by the giant resonance mechanism, followed by the second step of neutron emission. The daughter nuclei after the neutron emission may often be in excited states from where they decay finally by the characteristic gamma-emission. In some cases muon-capture followed directly by a gamma-emission (i.e. without the proceeding of neutron emission) has also been observed. A representative summary of the experimental results dealing with the above facts of the muon capture process, and their theoretical interpretation has been given in the article. The review ends with a description of various angular correlation results. Perhaps a slight elaboration here and there and a greater care in elucidating some of the basic terminologies (not very well-known to a non-specialist) would have relieved the article from its conference reporting style and rendered it more useful to a wider audience. On top of page there are some badly constructed sentences which have escaped the editor's attention.

The second article (49 pages) by F. Singer on the Emission of Particles following Muon Capture in Intermediate and Heavy Nuclei has, by the authors own admission some overlap with the first article. From a non-specialist's point of view the style here is more lucid than Uberall's. Although the emphasis is more on the experimental aspects, a fairly comprehensive account of the theoretical interpretation is also included. In addition to the neutron emission, the cases of charged particle-emission (like proton and alpha) following muon-capture have also been discussed. Once again several tables, designated as figures, should perhaps have drawn the editorial attention.
The last and the longest (253 pages) article is by J. S. Levinger on 'The Two and Three Body Problem'. It may be recalled that these topics were dealt with in another Springer Verlag series (Handbuch der Physik 39, 1957) many years ago in two separate articles by Hulthen and Sugarawa ('The Two-Nucleon Problem') and by M. Verde ('The Three-Body Problem in Nuclear Physics'). Levinger has shown a rare skill in combining the two topics into one article and, what is more important, in striking a balance in his presentation between pedagogy and reviewing. Although the author has restricted himself primarily to the application of the separable t-matrix in the study of the two- and three-body problems, the reader will get the references to the other approaches and also a synopsis of this type of work. In view of the recent developments in the unitary pole approximation and the unitary pole expansion of the t-matrix, Levinger's treatment of the subject is quite timely and instructive. Some of the flourish in the language of which this article has a generous sprinkling, and the frequent use of the first person singular number, seemed unnecessary to the present reviewer. But that has to do with the individual's taste.

M. K. P.

Oxide Semiconductors.


With the rapid increase in the applications of semiconductor techniques it has become necessary to find materials of varying physical and physico-chemical properties. These requirements cannot be fulfilled by a few semiconducting elements. The new materials which are at present being extensively investigated, the oxides of metals and semiconducting elements are potentially amongst the best. This is mainly due to their applications in electronics and microelectronics. However, till now only very few books and reviews dealing specifically with the preparation and properties of oxide semiconductors have been published. In that respect this book is a very welcome publication to the research workers in this and related areas.

Part one of this book deals with the preparation of oxide materials, their crystal growth and their film deposition techniques. The different methods have been described very clearly and competently in three chapters. Part two deals with the structure and different types of defects in oxide semiconductors which are essential for an understanding of their properties and also for the preparation of materials of specified properties. The last part of the book
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Deals with the structural and transport properties of a number of oxide semiconductors.

In a comparatively brief book the author has been able to present a wealth of information which will be invaluable to materials scientists. The translation from original Polish has been done competently.

A. K. B.

Physics of Rare Earth Solids

Edited by K. N. R. Taylor and M. I. Darby, Chapman and Hall, Pages 308.

Rare earth Physics is still a rapidly growing subject although interest in this field started long ago. It was high time that the subject needed a thorough review and the present contribution fulfils this long-felt need. The book is a very successful review containing most up-to-date information regarding the various properties of rare earth solids. The book describing the physical properties of rare earth in solid state broadly divides the subject into three parts—rare earth ions in insulating salts, rare earth metals and alloys and rare earth compounds of special interest such as semi-metallic pnictides, rare earth intermetallic compounds etc. Along with the systematic presentation of experimental results the authors discuss the theory necessary for each property in a manner compatible with the review nature of the book. The first chapter starting with the theory of free ions deals with fairly in details the various properties of rare earth ions in crystalline salts such as crystal field behaviours, magnetic and c.s.r. properties, spin-spin and spin-lattice interactions, specific heats etc. The remaining chapters except the last one deals with probably all the possible physical properties of rare earth metals and alloys including structural and elastic behaviours, energy band structures and band theory for magnetic and transport properties. The last chapter deals with rare earth compounds of special interest such as pnictides, compounds with oxygen, sulphur, selenium, tellurium, Group V elements, aluminium, transition metals, silicon, germanium, tin etc. The book is thus a comprehensive and up-to-date review of works on all possible rare earth solids. However, the reviewer finds relatively little mention of the spectral and optical properties of rare earth ions in crystalline solids. This field being very important in determining the energy level pattern and crystal field parameters of rare earth ions has attracted many workers for the last fifteen years and is still being pursued with much interest. Never-the-less the book is a highly valuable contribution and will be extremely helpful to both theoretical and experimental solid state physicists working on rare earth properties.

U. S. G.
The Physical Principles of Electron Paramagnetic Resonance


The present contribution is the second edition of George Pake's previous book on paramagnetic resonance published ten years ago. During this period the subject has undergone a substantial expansion and the authors have completely revised and enlarged the original book incorporating new and interesting works in the field and leaving out some of the discussions given in the first edition. In the second edition the authors have retained many features of the original version and some of these have been rewritten carefully. Although the title refers to electron paramagnetic resonance the book contains essentials of nuclear magnetic resonance as well.

The authors have given stress on physical principles rather than on experimental results and discuss the theories involved in e.p.r. results in terms of spin-Hamiltonian formalism which have been developed fairly in details using symmetry arguments. Important special features of the second edition are contained in Chapters 6-9 and Chapter 22 which include spin-spin, spin-lattice and exchange interactions, spin-phonon coupling, effects of stress and electric field on e.p.r. and electron nuclear double resonance. The book, although intended for graduate students of Western Universities, will also be useful to the advance workers in the field of magnetic resonance in general.

U. S. G.

Electrical Conductivity in Ceramics and Glass (Part B)


The present reviewer has already found Part A of this monograph in the Series 'Ceramics and Glass: Science and Technology,' to be highly useful and informative to the research workers as well as to the students taking advanced, course in solid state materials. This concluding Part B dealing with the electrical conductivity studies in ceramics and glass consists of five more chapters written by several workers, who are associated with this specialized branch for a sufficiently long period. Chapter five concerns the aspects of controlled valence effects in electronic conductors in which the electronic conduction predominates over the ionic conduction. In Chapter 6, a plausible interpretation of the behaviour of the highly conducting oxides, which have conductivities comparable to those of the metals from which they are derived, has been given from the theoretical considerations of energy band theory. The solid state switching phenomen-
non has been discussed qualitatively in the light of various models proposed recently including that of Mott Transitions. Applications of the proposed models have also been made in several oxide materials namely, VO$_2$, V$_2$O$_5$, and Ti$_2$O$_3$. This chapter is really interesting and deals with one of the most active areas of solid state physics. Chapter 7 gives a brief account of the theoretical aspects and application of ionic conduction and electrochemistry of ceramic compounds. The ionic conduction involving defect concentrations has also been discussed. The electrical conductivity, both ionic and electronic in glasses and amorphous solids has been treated in detail in Chapter 8. Since most of the ceramic materials used for technological applications are polycrystalline in nature microstructural and polyphase effects have been considered in the final chapter of this book (Chapter 9).

The two volumes of this book cover more or less all the aspects of electrical transport in amorphous and ceramic materials, both from theoretical background of solid state physics and also from practical applications in technologically important materials. Each chapter is well-written with up-to-date informations. This book will naturally be welcomed by a large section of workers in the ceramic technology. We eagerly await for the other monographs of the current series.

S. P. S. G.

**Constructive Quantum Field Theory,**


Axiomatic field theory had a spectacularly successful early phase, beginning with Wightman's famous 1956 paper, continuing through the late fifties and early sixties with the proofs of a number of important theorems and culminating in Ruelle's work (1962) on collision theory (this early stage is covered in the well-known books of Streater-Wightman and of Jost). After this heady beginning, progress was steady but slow for nearly a decade, along two essentially complementary lines: the algebraic approach associated with the names of Haag and his collaborators and the so-called constructive approach initiated and nurtured by Jaffe and Glimm. The book under review discusses in detail some remarkable new work along the constructive line; it is up-to-date as of Summer 1973.

Constructive field theory is concerned with the construction of models— as specified e.g., by the equations of motion satisfied by the quantum fields—
which are first of all required to have solutions satisfying well-known axioms (e.g., those of Haag-Kastler, Wightman). It then attempts to derive from these models information which is more directly physical such as the properties of the mass spectrum and the dependence of relevant amplitudes on coupling constants. It is distinguished from the traditional (perturbative) Lagrangian field theory in its insistence on absolute mathematical and logical rigour. These extremely difficult efforts have recently had much encouragement from the work of Nelson on the connection between the Wightman functions, which are vacuum expectation values of products of field operators, and the Schwinger functions which are the same quantities in a fictitious Euclidean space-time in which the distance between two points $x$ and $y$ is $(x_0 - y_0)^2 + (x_1 - y_1)^2$ rather than the Minkowski distance $(x_0 - y_0)^2 - (x_1 - y_1)^2$.

The lectures in this volume serve the purpose of taking stock of the post-Nelsonian situation as well as of identifying future lines of work. Nelson showed in his work how Euclidean boson field theories may be reformulated in certain probabilistic terms and how results proved for Euclidean field theories may be extended to Minkowskian field theories through a method of analytic continuation in the time coordinate. Subsequently a more direct and less probabilistic approach to this problem was found. Both these aspects of this new decisive step forward are discussed here, by Nelson and Osterwalder, respectively. There is also an extensive mathematical review of the relevant aspects of probability theory by Reed.

In spite of this decisive step forward, worthwhile progress is still confined to 2-dimensional (2 space + 2 time) theories. Consequently, the substantial contribution to this book are the lectures of Glimm, Jaffe and Spencer on 2-dimensional boson theories with a polynomial interaction ($P(\phi)^2$ theories). It reviews briefly the current status of $P(\phi)^4$ theories and then goes on to describe in some detail the way some of the more recent results have been obtained, by using post-Nelsonian methods to short-circuit the technical virtuosity required previously to prove less ambitious results. It is thus known now, for example, that, at least for small coupling constants, $P(\phi)^2$ theories have the right mass singularity structure and that they allow perturbation expansions in asymptotic series. Another major set of lectures by Guerra, Rosen and Simon deals with the intimate connection between relativistic boson fields theories and classical statistical mechanics. It uses the extensive knowledge that has been built up in recent years in statistical mechanics to prove a variety of results in Euclidean field theories.

There are a number of other lectures on related topics, of which one by Hepp, on his work with Lieb, on a rigorous approach to macroscopic quantum electrodynamics (as required to describe the situation in a laser beam) is notable.
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The level of mathematical sophistication required to understand much of this volume precludes any quick assessment of the details of these lectures (a fair amount of work in this subject is published in mathematical journals). Nevertheless, the importance of the endeavour described is beyond question. The amazing progress made in the field in the last five years is, optimistically, a pointer to even further progress in the future, from 2-dimensional superrenormalizable models to realistic 4-dimensional renormalizable models.

The exemplary speed of publication of this volume is worthy of special mention.

P. P. D.

Combinatorics and Renormalization in Quantum Field Theory


The book which grew out of a series of lectures given by the author at the Department of Theoretical Physics of Imperial College, London, consists of a review (with comprehensive references to the literature on the subject) of the combinatoric methods developed by him and his collaborators since the early fifties. The exposition is clear but a bit cryptic, and avoids most proofs. The main advantage of the method lies in casting expansions and formulas of quantum field theory into simple forms without requiring tedious diagrammatic expansions. Although no new physics can be learnt, lengthy and cumbrous proofs concerning, for example renormalization and counterterms, can be drastically shortened with the help of these techniques.

Fermi and Bose statistics are shown to require the use of the properties of \textit{pfaffians} (which often reduce to determinants) and \textit{hafnians} which often reduce to \textit{permanents} respectively. It is also shown that the method allows formal properties of a theory like, for example Lorentz and gauge invariance, unitarity, locality, etc., to be exhibited clearly throughout.

Analytic problems have also been treated. Regularization in $x$-space and renormalization have been discussed. One important result that has been obtained with comparative ease by the use of combinatoric techniques is the physical equivalence of different regularization and renormalization methods. A brief mention of the \textit{renormalization} group is made in this context.

The behaviour of some simple approximations and solvable models has also been treated. In all such cases the physical mass appears as the solution of a mass equation which admits of several solutions. The question of the existence and uniqueness of these solutions has, however, been left open.
An important application of the methods to the study of the Ising model has been (purposely) omitted.

These methods may prove useful and powerful in studying formal properties of unified gauge theories (with or without spontaneous symmetry breaking) like gauge invariance, unitarity and renormalizability.

The book is likely to interest those inclined to formal thinking.

P. G.

Crystal Physics Macroscopic Physics of Anisotropic Solids

Edited by Hellmut J. Juretschke (1974). Published by W. A. Benjamin Inc.

This monograph of the Modern Physic Monograph Service—edited by Felix M. H. Villars is a welcome addition to the books on crystal physics. The book deals with the macroscopic properties of crystals. Almost all the conventional properties arising out of different interactions have been dealt with by the author. Due to the emphasis on the microscopic treatment of those interactions, the macroscopic physics is mostly neglected. But it is very helpful to know the form of the effects and their dependance on symmetry of the crystals. This book clearly brings out the importance of such studies. The first four chapters deals with the description of symmetries possessed by crystals—the translational symmetries and the point group symmetries in two and three dimensions and the mathematical description of the macroscopic properties of crystals—their transformations under coordinate transformation and their dependance on symmetries of crystals. Though the symmetries of crystals are not thoroughly discussed the basic concepts are elegantly expressed. The characterisation of the symmetries by their group properties is an useful addition. In the treatment of the transformations of the tensors under various symmetry operations instead of the application of general formula a useful simpler direct inspection method is presented. In the subsequent chapters—the electric polarisation, electrical conduction, Hall effect, thermoelectricity, crystal optics, elasticity, piezoelectricity etc. are discussed in relation to the mathematical formulations laid down before. Lastly the addition of a number of appendices giving the point groups, their irreducible representations and tensor invariants has increased the usefulness of the book. The book, however, will not be appreciated by beginners who are not familiar with Group theory and linear algebra. The book with the problems set after each chapter, will serve admirably as a supplement to the existing text books on crystal physics.
The subject of this book, symmetries in physical systems, with particular focus on atomic nuclei, is of the utmost importance in modern physical science. In contrast to most treatments, frequently characterized by fearsome formalism, this book leads the reader step-by-step, in an easily understandable way, through this fascinating field.