BOOK REVIEWS

QUANTUM THEORY OF SOLIDS—C. Kittel. Published by John Wiley & Sons, Inc. 1963, pp. 453, Price $ 13.50.

Professor C. Kittel's earlier contribution "Introduction to Solid State Physics" is well known to students and teachers of solid Physics, and has been widely accepted as a general text book for an introductory course in this developing branch of physics. The present contribution is intended for more advanced studies purely on the theoretical aspects of solid state physics, and may be considered as a natural extension of his earlier one, although a gap seems still to exist between the two contributions.

The book starts with a brief mathematical introduction stating the useful formulae of crystal physics and quntum mechanics necessary for calculations of solid state theory. The various excitations in solids have been dealt with very thoroughly in the first few chapters. The advanced theoretical treatment of field particles, phonon, magnon, plasmons, polarons, excitons etc. will interest the students of not only solid state physics but also quantum field theory and particle physics. The book covers the theoretical aspects of almost all essential topics of solid state physics including theories of energy bands, Brillouin zones, Fermi surface, metals and alloys, superconductivity, semiconductor properties, magneto-resistance, magneto-dynamics in solids etc. The reviewer is particularly happy to find a separate chapter entirely devoted to Green's function technique which is often used very profitably in solving many problems of solid state theory. The main text in each chapter has been followed by a set of illuminating problems, left to the students as exercise.

The method of second quantization has been necessarily and frequently used in the first part of the book, and it would have been more appropriate if an introductory note on second quantization technique were included in the very first chapter on "Mathematical Introduction". The reviewer would have been happier if he could find a more elaborate treatment on the calculation of band structure in solids with specific expamples and a separate chapter on the theories of various relaxation processes in solids.

The author has stated in the "Preface" that the present contribution is intended for use in a one year graduate course and the object of this text book is to present the central principles of quantum theory of solids to theoretical physicists generally and to those experimental solid state physicists who have had a one year course in quantum mechanics. In view of the very sophisticated nature of theoretical treatment of the most modern topics using advanced quantum mechanical techniques it is doubtful whether this new contribution may be regarded as a text book for graduate course at the present state of academic curriculum, usually followed by the universities. Moreover, the experimentalists, even after going through one year quantum mechanics course, are likely to find the presentation difficult. In the opinion of the reviewer this new contribution will be undoubtedly welcomed by the theoretical physicists working on solid state physics and quantum field theory. They will find to their statisfaction that most of the basic materials of their interest are wellknit in a compact form and thus save much labour in searching huge volumes of scattered literature.

U. S. G.

ADVANCED QUANTUM THEORY—by P. Roman. Published by Addison-Wesley publishing Co. Inc, 1965, pp. 735, price $ 17.50.

There is a growing feeling that the course of quantum mechanics should be divided into two parts, elementary and advanced. In fact, many universities now-a-days offer two courses

on quantum mechanics. But the topics covered in the courses vary from school to school. Here is a highly valuable contribution by Professor P. Roman which can serve as a proper text book and resolve the difficulty often encountered by the academic experts regarding the contents of a unified course of quantum mechanics, split into two parts.

The present contribution is entirely devoted to the advanced course, though the author with a high degree of skill in presentation starts from the basic postulates of quantum mechanics. The whole advanced course is so clearly and lucidly exposed that it needs very little preliminary knowledge of the elementary quantum mechanics. The contents are broadly divided into three parts. Part I deals with the framework of quantum theory including topics like second quantization, density matrix, time-development of quantized states, relativistic quantum mechanics etc. Part II mainly deals with collision theory and scattering, and contains topics like method of partial waves, dispersion relation, time-dependent approach to scattering theory, S-matrix, T-matrix, application of the collision theory to many-body problems etc. The reviewer is particularly happy to find the contents of Part III which is entirely devoted to symmetry properties of quantized systems and application of group theory to quantum mechanics. Concepts of symmetry and group theory are not only helpful in simplifying the procedures of quantum mechanical calculation but also highly valuable for a clear understanding of its principle. The author has rightly included it in the advanced course on quantum mechanics. Part I and II thus provide the knowledge of fundamental principles necessary for tackling the various problems of atomic, molecular, solid state physics and nuclear physics, field theory, particle physics, respectively, while part III is meant for strengthening the conceptual basis and general background of quantum mechanics. Each chapter ends with a brief summary and a number of systematically arranged illuminating problems, left to the students as exercise, where they will find the application of the basic principles developed in the text. The academic value of the book has been further enhanced by the inclusion of four important appendices on linear algebra and Hilbert space, group theory, Dirac equation and Green's function technique.

In the preface of the book the author has been outspoken in pointing out the misinterpretation of the oft-repeated argument that things are learned through their application. He writes "Physics, unlike agriculture, plumbing or even engineering at its very best is not merely a professional activity. In bygone days physics was often referred to as natural philosophy. Physics has been the product of ever searching, restlessly enquiring, wondering human mind, the outcome of a longing for understanding and appreciating the world we live in. It is this aspect of Physics which in this book, I tried to stress most." Indeed, the author has been very cautious in confining the students most to the conceptual area and logic of quantum mechanics. He is against any premature rush into applications before completing a systematic survey of the field and an adequate assimilation of the fundamental ideas and methodology. Often such premature rush leads to confusion and wrong conclusion. The reviewer is probably one of the few persons who entirely agree with the author. However, application and conceptual basis can always be made complementary, and the author would not have gone against his own principle if a few applications were included in the text with an eye to enhancing the conceptual basis and clarifying abstract logic.

U. S. G.

THE THEORY AND PRACTICE OF SCIENTILLATION COUNTING—by J. B. Birks, Published by Pergamon Press.

This book is a good replacement of an early book "Scintillation Counters" published in 1953 written by the same author. As the title indicates the book treats the theory of the scintillation mechanism and application of the scintillation counter. It is a good collection

of the development in the theoretical and practical aspects of scintillation counting. There is no other book in this line which is not already outdated and as such is useful for those who are developing new scintillators and for those who are using the scintillation counting arrangement. A major portion in the book is devoted to the scintillation process in organic, inorganic and other phosphors and acts as a guide and starting point for further research in developing new phosphors. Though the different components comprising the scintillation counter is discussed, its uses are so numerous that full description of all its applications is not possible even in this large volume and the author has very ably outlined the different applications with a good bibliography for any one interested in a particular application to find the early work quite easily. It is a good book in any library open to users in this field.

A. P. P.

ELEMENTARY PARTICLES & COSMIC RAYS By Alladi Ramakrishnan Published by Pergamon Press, London.

This is a comprehensive text-book on the theory of elementary particles, their interactions being described through quantum electrodynamics and through cosmic ray phenomena. Throughout, a physical approach has been made to the problems involving and characterized by complex, formal mathematical methods.

The book is divided into two parts. Part I covers the major portion of the book and is devoted to the theory of elementary particles and gives an integrated account of the quantum mechanical collision processes, meson physics and strange particles. The first two chapters give a detailed description of strange particle interactions. A systematic account is given of free particle wave functions of various elementary particles with the corresponding attributes embedded suitably in the wave function subject to the constraints of relativity. Particle interaction is then described through perturbation theory for a non-relativistic system. The kernel function formalism of Feynman and its relation to field theory have been described by introducing the concept of negative energy.

The author has used probabilistic approach extensively to the theory of scattering and perturbation expansions as well as in the theory of cascades in Part II. The stochastic processes in cascade theory is very well covered, thanks to the author's own original researches in this subject. Part II deals with the cosmic ray phenomena. Chapter X deals with the primary cosmic radiation and time variations. Unfortunately, this chapter on one of the most active fields of present-day cosmic-ray research has been scantily covered. Modulation effects barely get a page and the several theoretical models suggested for the diurnal and other modulation effects are insufficiently described. However, the "Interaction of Cosmic Rays with Matter" has been well taken up in Chapter XII. The theories on multiple production by Heisenberg, Fermi, Bhabha and others have been presented clearly and in sufficient detail.

The book, on the whole, is an excellent attempt to give an integrated presentation of some of the major fields in modern physics. It is a required reference book for all research workers in cosmic rays and theoretical physics. Also, this book is a "pedagogic necessity" in countries like India to meet the needs of the revived interest in theoretical physics and mathematical sciences.

S. D. C.

COLLECTED PAPERS OF KAPITZA VOL. 3. by D. ter Haar, pp. 224, Price 84/-sh, 1967. Pergamon Press.

This volume comprises a miscellany of papers, reviews, lectures, biographical memoirs, and philosophical articles representing a good cross section of the many sided activities of Professor Kapitza's mind.

The first published paper of Kapitza on cod liver oil is as far apart from his later works on ultra-magnetic fields or liquid helium machine or future of science, as is heaven from earth, but nevertheless gives interesting details of the primitive method of catching cod and extracting its liver oil in Russia.

Since Kapitza's review on the now obsolete book on Magnetism and Atomic structure by Stoner was published, the science of Magnetism has taken over entirely the new garb of Quantum Mechanics and assumed all the importance in revealing secrets of atomic and molecular structure, as well as in giving man control over electronic and even nuclear motions as predicted by Kapitza. Momentary high fields exceeding by one order, from those produced by Kapitza, have been generated leading to interesting revelations of atomic and nuclear binding energies. On the one hand, research on supraconductors has made feasible a supraconducting magnet giving a steady field of about 150 kilooersteds, on the other hand electronic devices have overcome the problem of breaking a power of the order of 10^5 kw through a small coil to give pulse fields of $\sim 10^6$ oersteds for a few milliseconds.

In reading through the article on the Institute of Physical Problems, which the present reviewer had the good fortune of visiting personally in 1956, it is felt that the remarks on the sophistication in equipments and the difficulties in procurement of such, apply with equal force today in most of the Indian research laboratories.

Four of the articles are aptly devoted to the memories of Rutherford, foremost of the pathfinders of the modern nuclear age, one of whose most renowned "boys" was Kapitza.

Without going into a detail of the other articles it suffices to say, wherever one opens the volume some originally interesting aspect catches the eye and fixes it until the article is finished and then one craves for more. One is, however, apt to be critical of Kapitza's attitude towards the German scientists in the article "We fight for freedom." In spite of what U.S.S.R. and other countries suffered in their fight with Kaiser's or Hitler's ideological Germany, it would be puerile to shut ones eyes to the achievements of German scientists, philosophers, literatures, poets, artists and composers.

A. B.

1. Quantum Mechanics and the FermiDirac distribution The most fundamental postulate of quantum mechanics is that variables which were continuous in classical mechanics are actually discrete, or quantized. This includes several variables (e.g. momentum), though we will focus on the quantization of energy.Â The preceding analysis was crucial in solving the mystery of predicting the heat capacities of solids. Classically, it was believed that every electron would contribute to 3kB to the heat capacity, but this led to large overestimations. However, the Fermi-Dirac distribution shows that the vast majority of electrons will be â€˜frozenâ€™ at low energies even at moderate temperatures. Quantum Theory of Solids is a modern presentation of theoreticalsolid state physics it builds directly on the same author? sIntroduction to Solid State Physics and is planned as a one yeargraduate course for experimental and theoretical physicists it iswell-suited for self study because the text contains 110 problems.The first part of the book treats phonon, electron, and magnonfields, culminating in the. BCS theory of superconductivity. Thesecond part considers Fermi surfaces and electron wave functions,and develops the group theoretical description of Brillouin zones.The third part applies co This book is written for the student of theoretical physics who wants to work in the field of solids and for the experimenter with a knowledge of quantum theory who is not content to take other people's arguments for granted. The treatment covers the electron theory of metals as well as the dynamics of crystals, including the author's work on the thermal conductivity of crystals which has been previously published in English.