PHYSICAL SCIENCES

Magnetism

Magnetic Interactions in Solids. By H. J. Zeiger and G. W. Pratt. (The International Series of Monographs on Physics.) Pp. xv+660. (Clarendon Press: Oxford; Oxford University Press: London, June 1973.) £19.50.

MAGNETISM is a fundamental part of most topics in solid state physics. It is usually recognized in the form of ferro-, ferri- or antiferromagnetism, but probably less easily so in the case of spin-waves or domain structures. Such bulk properties describe ordered magnetic systems but any real explanation of these phenomena must ultimately depend upon the electrons and nuclei of the system and on their interactions with each other and with any externally applied perturbations. The authors' aim in writing this book is to develop systematically the underlying theory of such interactions, emphasizing particularly the physical interpretation of the theory rather than using a rigorous mathematical formulation.

The first chapter introduces the magnetic Hamiltonian. It is used to describe the interaction of an electron with external electromagnetic and uniform magnetic fields, with the atomic nucleus and with other electrons. The orbital and spin contributions are distinguished and relativistic corrections are considered. The next chapter describes the magnetic properties of one-electron atoms. The effects of spin-orbit coupling and the Zeeman interaction are discussed in detail and some of the important terminology is introduced at this stage. The next step is to derive the magnetic properties of many-electron atoms, and this forms the basis of the next chapter. Some of the fundamental principles of indistinguishability are discussed first of all and used in the setting-up of effective one-electron Hamiltonians. The Hartree–Fock approximation is then considered and the L–S and j–j coupling schemes are explained. Calculations of the coulomb and spin-orbit interactions are given in detail and the general magnetic properties of atoms are discussed.

The detailed chapter on the magnetic properties of ions in crystal fields is the longest in the book. The approach is not conventional in so far as the crystal field approach is described by considering in detail the examples of Cu^{2+} and Ni^{2+} ions in octahedral surroundings, while the rare-earth ions are mentioned only briefly. The concept of the spin Hamiltonian is introduced and covalency effects are treated in some detail. There are two further long sections in this chapter—one discusses the Jahn–Teller effect and the other considers exchange interactions in insulating crystals.

Having discussed at considerable length the properties of systems in which the electrons are localised around particular defect ions in a solid, the other extreme approximation in which the electrons are completely free is then analysed. The one-electron band approximation is introduced and the paramagnetism of the conduction electrons is calculated. The properties of electrons when a magnetic field is applied are then considered in detail—the eigenstates are calculated, cyclotron resonance examined and the interaction with acoustic waves is described. The de-Haas-van-Alphen effect is then described and its importance in determining the Fermi surface in metals is emphasised. This is followed by a discussion of the energy of electrons coupled to lattice vibrations in the presence of a magnetic field and by conduction electron spin resonance and nuclear magnetic resonance in metals.

The next chapter discusses the $\mathbf{P}.\pi$ perturbation theory and the effective mass approximation (where $\mathbf{P}$ is defined as $\mathbf{p}+(e/c)\mathbf{A}$ and $\pi=\mathbf{p}/m$) particularly for the case of band electrons in a magnetic field. The effective mass concept for the electron in many situations is discussed. This is followed by an analysis of interband and intraband transitions and the effect on transitions by an externally applied electric field. Faraday rotation and the magneto-optic Kerr effect are then considered.

Magnetic interactions in semiconductors and metals are the subjects of the last two chapters. Donor and acceptor states for Si and Ge are considered in detail and their properties when a magnetic field is applied are analysed. It is shown how e.s.r. and e.n.d.o.r. can be observed in donor and acceptor states. The concept of an exciton is also introduced. In the case of metals, the existence of localised moments is examined and their effect on the conduction properties is discussed. Then it is shown how indirect exchange interactions and hyperfine effects can also be observed in metals. A ninety-page appendix on assorted topics is included at the end of the book and provides further very valuable background material.

This book, then, covers in considerable detail the fundamental problems of magnetic interactions in solids and would appear to be one of the most comprehensive texts on the subject. It could be argued that it is not complete as the fundamental ideas have not been applied to explain the properties of ordered magnetic systems. The authors have quite clearly decided, however, that the more fundamental approach is preferable and have left it to others to apply their ideas to the bulk properties of magnetic materials.

The material is presented in a logical sequence and in a self-consistent manner; but for a book of this size, relatively few references have been given. In particular, in the very long section on crystal fields, I am very surprised that no reference or use has been made of the basic crystal field calculations of Hutchings or the tensor operators listed by Smith and Thornley. Also the subject matter of this chapter has considerable overlap with *Electron Paramagnetic Resonance of Transition Ions* by Abragam and Bleaney. This is somewhat surprising as both books are in the *International Series of Monographs on Physics* published by the Oxford University Press.

While the standard of the printing of the text, figures and the large amounts of mathematics is first class, I have two criticisms of the presentation of the book. First, I believe that chapter and section numbers should be at the top of every page. Second, references take some time to find as they are given at the end of each chapter, often at least 100 pages or so further on. It is not easy to find the end of the chapter you are reading without labels at the top of the page.

I am sure the book will prove invaluable for all postgraduate students working in solid state physics and will be a constant source of reference for all other research workers. In common with most high-quality physics books today, it is priced well outside the range of an individual's pocket, but is an obvious definite buy for libraries and research groups with sufficient funds.

C. A. BATES

Physical Chemistry

A Textbook of Physical Chemistry. By Arthur W. Adamson. Pp. xxi+1079. (Academic Press: New York and London, 1973.) $16.95.

THIS book covers, with a certain freshness of approach, much of the ground conventionally assigned to physical chemistry. Stress is appropriately laid on the need for precision in recording kinetic, thermodynamic and spectroscopic data. Each of the twenty-one chapters is followed by lists of references and numerical answers to problems. There is also a subject index to the whole book.

A slight danger lurks in the method presented for deriving certain integrated rate equations, but fears are allayed when it is once realized that, apart