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Review of *Quantum States of Atoms, Molecules and Solids*

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Quantum States of Atoms, Molecules and Solids

M. A. Morrison, T. L. Estle, N. F. Lane
575 pp. Prentice-Hall, Englewood Cliffs, N.J., 1976. $25.50

The subjects of atomic, molecular and solid-state physics have only rarely been treated at an advanced level in a single volume. The notable exception, of course, is John C. Slater's *Quantum Theory of Matter.* In the present book the three authors, Michael Morrison, Thomas Estle and Neal Lane, stress the unity among these fields by emphasizing the concept of electronic quantum states in atoms, diatomic molecules and crystalline solids. Such a combination should be of basic interest to students in a variety of scientific fields and also forms the basis for more advanced work in those three subjects themselves. This is a textbook of applied quantum mechanics directed to advanced undergraduate and graduate students in physics, chemistry and engineering; the authors assume a previous introduction to quantum mechanics.

After a review of basic quantum mechanics, the first part contains the solution to the one-electron atom, two chapters on approximation methods, two on spin and three on multi-electron atoms. In Part 2 the authors treat the diatomic molecule, first through the use of an exactly soluble one-dimensional model and then by approximation methods applied to a three-dimensional model. The emphasis is heavily on electronic states; vibrational and rotational motion are treated only very briefly at the end of the section.

In the third part, after a preliminary discussion of crystals, lattices and Brillouin zones, we get into a perturbation treatment of a one-dimensional model using the free-electron and the weak-binding approximations. Step by step, the authors then take us through two dimensions and finally to three, where concepts such as energy bands and the Fermi surface are introduced. As in Part 2, the principal focus is on electronic states, but a final chapter on vibrations in solids helps to round out the picture. The five short appendices include a welcome one on atomic units.

This carefully thought out and well written book should provide the student with a well paced introduction to each of the areas under consideration, at a somewhat lower level than Slater's book.

Each chapter has a set of problems, graded according to their difficulty by several groups of students who have studied the material at Rice University. The authors' occasional use of whimsical section titles (such as "The Disappearance of Diabolical Degeneracies") and their inclusion of well chosen quotations at the beginning of each chapter help to maintain a sense of liveliness. This feeling also comes through in their style of writing.

My chief complaint about the book is its complete lack of any connection to experiment. No photographs of spectra, no tables of data, no comparisons of deduced results with any experimental values appear in this book. In fact, virtually no reference is made anywhere to the real world. At some time or other we have all heard and been appalled by stories of the early Greek philosophers, who deduced many results through their logical analyses from theoretical models but who refused to make even the simplest experimental tests to see if their deductions agreed with observations. Perhaps today we are moving back in that direction; this book is not the only one that ignores the question, "Do this model and the deductions based on it have any correspondence with physical reality?" If you want a book to help teach your students to apply quantum-mechanical methods to the central-force problem, the one-dimensional N-electron atom, the double square-well potential and other theoretical models, this book will do it and do it well. But if you feel that students also ought to acquire some basis for judging the validity of models or that they should learn something about how to inquire into the way Nature behaves, then this book must be supplemented with other material to provide a complete presentation of atomic, molecular and solid-state physics.

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