

pretation in a new area the importance of which this volume has convincingly demonstrated.

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Quantum Mechanics

Donald Rapp
638 pp. Holt, Rinehart and Winston, New York, 1972

Donald Rapp, of the University of Texas at Dallas, has considerable experience in the study of atomic and molecular collisions, and these interests are clearly reflected in his book on quantum mechanics. The book may be most valuable to chemistry students since it provides an introduction to the theory of collisions as well as discussing the properties of stationary states in simple atoms and molecules. Research into collision processes is being pursued vigorously in many chemistry departments, but most textbooks on theoretical chemistry give little attention to this topic. Physics students who are particularly interested in atomic physics may also find the book useful.

A major theme throughout the book is the comparison between time-dependent and time-independent quantum mechanics. The first four chapters are devoted to a mathematical treatment of wave packets that may severely test the perseverance of students who find mathematics difficult or tedious. In later chapters the time-dependent theory is developed into the semi-classical theory of heavy particle collisions, and this development provides one of the most valuable portions of the book.

The influence of Rapp's chemical background is evident in the chapters on exact solutions to one-dimensional problems. The traditional treatments of bound states in the square well and harmonic oscillator potential are supplemented with a solution for the Morse potential, and transmission probabilities are calculated for the Eckhart barrier as well as the more familiar rectangular barrier. These calculations are followed by a comprehensive presentation of the JWKB approximation, and an interesting comparison between exact and approximate methods is possible. In this section the concept of resonant scattering is introduced, but this topic is not developed in the later chapters on electronic and atomic collisions. By failing to follow up this concept, the author misses an opportunity to link some of the basic formal theory with an active research area.

Following a discussion of the exact solution of the three-dimensional

Schrödinger equation, through the separation of variables, Rapp discusses two further approximation techniques, namely perturbation theory and the variational method. The Rayleigh-Ritz variational method for bound states is described, followed by several applications to small atoms and diatomic molecules. The systems chosen for these examples have at most three electrons, and the special techniques, such as the Hartree-Fock and Thomas-Fermi methods, that have been developed for larger systems are not discussed.

Much of the concluding section of

the book is devoted to scattering theory. The description is in terms of phase shifts and scattering amplitudes. Many formal equations receive little or no attention—I could find no reference, for example, to any of the scattering matrices, or to unitarity or detailed balance. There is a brief discussion of the behavior of the phase shifts for elastic scattering at very low energy, but the conditions under which this analysis is applicable are incorrectly stated. The major aim of the author appears to be to demonstrate how a few important methods are actually applied. The excitation and ionization

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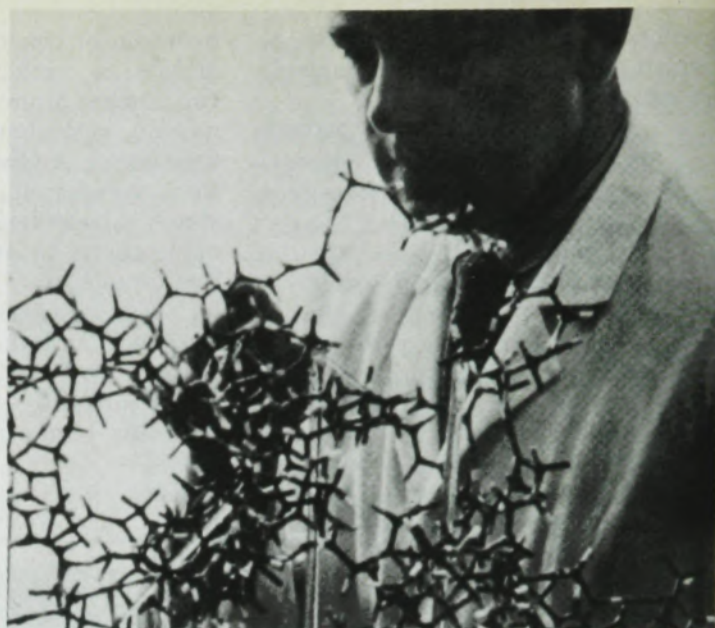
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of the hydrogen atom by electron impact is described at great length in terms of the Born approximation. There is very little discussion of the effects of exchange, or of distortion of the target atom, upon electron scattering. The application of quantal and semi-classical methods to the study of charge transfer in ion-atom collisions is also discussed at length, and there is a brief introduction to the theory of atom-molecule reactions.

Many aspects of quantum mechanics are not included in this text, and several of the missing topics are relevant

to atomic physics. There is little or no reference to relativistic effects or spin-orbit forces, and the effects of electromagnetic fields on atoms and molecules are not discussed, except in regard to the calculation of radiative transition probabilities.

Although the author has tried to demonstrate the application of quantum mechanics to specific problems, and the specialization to atomic problems is helpful in this respect, more comparisons between theoretical results and experimental observations would have been valuable. For example, the vibrational modes of CO_2 molecules are discussed, but the relative magnitudes of the normal modes are not indicated. The figures showing theoretical scattering cross sections do not show experimental values, even where these are available.

Although there are problems at the end of some chapters, the total number is small. One additional problem that could be posed to students is to discover the error in the table of physical constants. The values contained in this table are inconsistent, and the explanation of this error involves a feature of the hydrogen atom that is often overlooked.

J. N. BARDSLEY
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new books

Elementary particles and fields

The Physics of Elementary Particles. L. J. Tassie. 255 pp. Halsted, New York, 1973. \$10.50

Nuclei, nuclear physics

Atomic and Nuclear Data Reprints, Volume 1, Internal Conversion Coefficients. K. Way. 380 pp. Academic Press, New York, 1973. \$12.50

Prompt Fission Neutron Spectra (Conf. Proc. of an IAEA Consultants' Meeting, Vienna, 25-27 August 1971). 176 pp. UNIPUB, Vienna, 1972. \$6.00

Atoms and molecules

Atomic and Nuclear Physics. K. G. Krishnan. 564 pp. Macmillan, Madras, India, 1973. Rs. 35

Chemical physics

Advanced Molecular Quantum Mechanics. R. E. Moss. 300 pp. Halsted, New York, 1973. \$18.50

Materials science

Gallium Arsenide and Related Compounds. (Conf. Proc. Fourth International Symposium on Gallium Arsenide, Boulder, Colo. 25-27 September 1972). C. Hilsum, ed. 302 pp. Inst. of Physics, London, 1973.

The Principles of Engineering Materials. C. R. Barrett, W. D. Nix, A. S. Tetelman. 554 pp. Prentice-Hall, New Jersey, 1973.

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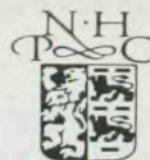
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