

Group theory and electronic states

Symmetry of Many-Electron Systems. (Physical Chemistry: A Series of Monographs, vol. 34.) By I. G. Kaplan. Translated by J. Gerratt. Pp. xii+370. (Academic: New York and London, February 1975.) \$34.50; £16.55.

GROUP theory has been used for many years in the quantum mechanical analysis of many particle systems. This monograph deals only with applications to many electron systems, specifically atoms and molecules, the physical properties of which reflect both the symmetry with respect to the permutation of the identical particles of which they are composed and the symmetry of the potential field formed by the nuclei within which these particles move. Other fields of application are ignored.

The book opens with an account of some of the main facts of group representation theory presented as a tool for the chemist, which omits many of the proofs and derivations. The permutation group is singled out for detailed study, an understanding of Young tableaux and Young operators being essential in later chapters. Linear groups of transformations (including the three-dimensional rotation group), point symmetry groups,

and the construction and uses of tensor representations and irreducible tensor operators are all described briefly.

The rest of the book is devoted mainly to the classification and calculation of electronic states of atoms and molecules. Considerable use is made of fractional parentage expansions, which are worked out in detail for the atomic case in $j-j$ coupling and then generalised to handle the non-vector-coupled states that are of importance in molecules. They allow one to construct matrices of one and two-electron operators for an arbitrary molecular system, and in particular to deduce the form of the Hamiltonian matrix. The book ends with an account, specially prepared for the English edition, of Hartree-Fock theory in an orthonormal orbital basis, a survey of methods of treating electron correlation and derivations of self consistent field equations for configurations of spin-degenerate states and for a configuration of non-orthogonal orbitals in the method of 'different orbitals for different spins'.

The calculation of a molecular structure involves a number of successive stages: mathematical methods are first of all needed to formulate appropriate equations for the problem; a numerical method must be devised to solve the equations as economically as possible; the solution must be performed to give

numbers; finally the numbers must be interpreted to give insight into the physicochemical problem under study if possible. The laborious and expensive nature of these calculations reflects the fact that none of these stages are trivial; however, Kaplan only considers the first of them. The group theoretical techniques that he describes are immensely powerful, but are sometimes handled in an uncritical way, as in the use of Young tableaux in the description of the Heitler-London calculation for H_2 . Several types of calculation are described, some of which have not yet been implemented in practice, without any discussion of their advantages or disadvantages, consideration of alternative methods, or presentation of numerical results. This lack of critical discussion means that the book is likely to be of most use to the experienced theoretician who wishes to understand how to exploit the techniques in his own work. The novice would find it tough going and would also be put off by the prohibitively high price.

The translation has been carefully done and I only detected a small number of relatively trivial errors. The original Russian text dates from 1969; consequently, the majority of the references are to literature from earlier years though a handful are of more recent origin.

I. P. Grant

Integrated biology

The Peripheral Arterial Chemoreceptors. (Proceedings of an International Workshop.) Edited by M. J. Purves. Pp. xiii+492. (Cambridge University Press: London, June 1975.) £14.00; \$39.50.

THE carotid body seems to have been the subject of more papers (per weight of tissue) than any other vertebrate sense organ; yet it is probably the least understood in terms of its functional morphology. In recent years this situation has been compounded by the publication of conflicting data, which was the main reason for convening a work session at Bristol in 1973. The present book is the outcome of this meeting.

Unfortunately, the editor gives no indication in the Preface or elsewhere in the book as to what the major unresolved problems and areas of contention are. Furthermore, there is no epilogue to indicate whether, or to what degree, the symposium was successful in resolving any of the controversial areas of research. The reader is therefore left with no alternative but to read the entire book to ascertain where the problem areas lie. Not that this is an unrewarding enterprise: all the articles are well written and of a very high standard.

Perhaps the greatest value in this book lies in the discussions at the end of each

paper, for it is among these pages that the reader is made aware not only of the specific problems in carotid-body research, but also of the subjective nature of the so-called exactness of the scientific method. For example, it is apparent that recognition of nerve processes in electron micrographs is achieved at least as much by intuitive as by objective criteria (page 39).

The subject matter ranges from ultra-structural studies, through neuropharmacological, neurophysiological and metabolic aspects of the carotid body sense organ, to circulatory and respiratory chemoreflexes in the whole animal. In general, the presentation is excellent, which is probably why the few minor editorial faults in the book are so irritating. The electron micrographs are displaced from both text and the legends so that the reader has to keep track of three pages simultaneously if he is effectively to follow the anatomical contributions. Some of the electro-neurograms are poorly reproduced and there are a number of mistakes in the reference lists.

Nevertheless, these faults do not detract from the overall excellence of this book, which can be recommended unreservedly not only to mammalian physiologists, but to all who are interested in an integrated approach to problems in biology. **M. P. Osborne and P. J. Butler**

BOOKS

ON PURE AND APPLIED SCIENCE

Books reviewed or mentioned in this journal are available from stock.

Catalogues on application.

Please state interests.

SCIENTIFIC LIBRARY

ANNUAL SUBSCRIPTION from £4.00

Reduced rates for multiple subscriptions

Available in U.K. only

Prospectus free on request

H. K. LEWIS & Co. Ltd.

LONDON: 136 GOWER STREET,
WC1E 6BS

Telephone: 01-387 4282

Circle No. 17 on Reader Enquiry Form.