

BOOK REVIEWS

The Chemical Bond and the Structure of Molecules.

J. K. Syrkin and M. E. Diatkina

Gozhimizdat, Moscow, 1946

This book, written by authors well known for their valuable contribution to the resonance theory of aromatic hydrocarbons and inorganic complexes, is a first-hand treatise on the quantum mechanics of structural chemistry. It is intended as a text-book for advanced study by university students in chemistry.

The book begins with the usual wave-mechanical treatment of the hydrogen atom (Chapter I). Then follows a detailed description of the rules, regulating the distribution of electrons in other atoms and of the principle, according to which the periodic system of elements is being built up. Chapter III is devoted to the quantum mechanics of the localized covalent bond. The one-electron bond in the H_2^+ molecule is dealt with first. Then follows the traditional presentation of the Heitler-London theory of the electron pair bond in the hydrogen molecule, the electron spins being taken into consideration. The authors give full understanding to the reader of the simplifications and shortcomings admitted in the actual computations.

Chapter IV is dealing with the following topics: the saturation of the valencies, their spatial distribution, the hybridization of the valence electrons, and finally, the σ - and π -types of bonds.

The delocalization of the π -electrons and the theory of resonance of various structures of the molecule are treated in the following two chapters (V and VI). These chapters, written mostly in a clear non-mathematical language, will be appreciated by the general reader to whom the mathematical exposition of the previous parts of the book, presents some difficulties. An original feature of the authors' exposition of the theory of resonance is the emphasis which they lay upon the existence of an intermediate valence structure of the molecule in addition to the limiting structures which are usually the only ones taken into consideration. Among the numerous examples of molecular structures dealt with in this part of this book, we find here many taken from the original papers of the authors, as, *e. g.*, the various resonance structures of naphthalene with their specific weights, and other ones.

The three Chapters IX, X, XI contain a wealth of various experimental data, which form the basis of the theory of resonance and are considered as overwhelming evidence supporting the reality of the phenomenon of electron delocalization. These chapters are dealing with the interatomic distances, the vibration frequencies, dipole moments and bond energies, mostly in organic compounds.

Chapter VIII, opening this section of the book, gives valuable information about the simplest, *i. e.* diatomic molecules, gained mainly from spectroscopic data.

A difference between the book and the well known monograph by Pauling on a similar subject is that, in addition to the method of localized electron pairs used by this author, in the book reviewed here due place and consideration are also given to the method of molecular orbitals. This method is outlined in Chapter VII, where both methods are being critically compared and their drawbacks made clear. A presentation of the method of molecular orbitals is given in the final Chapter (XVII) which contains several examples of computation, with all details, brought to completion. This Chapter and also Chapter XVIII will be very useful to those students of the subject, who are wishing to try their hand at the calculation of a definite structural problem.

The second half of the content of the book deals with forces uniting separate molecules into different kinds of aggregates. Chapter XII gives correspondingly a picture of the quantum mechanical origin of the non-selective cohesion (dispersion) forces of the van der Waals' type. Separate paragraphs in this chapter give a concise treatment of the hydrogen bond, of the molecular compounds, formed through the agency of covalent bonds and finally, of the internal rotation of atomic groups in a molecule.

A large Chapter XIII deals with various kinds of bonds in crystals. A novel feature which will be especially appreciated by inorganic chemists is Chapter XIV devoted to the structure of complex compounds.

Chapter XIV, dealing with the structure of boron hydrides, forms a very valuable and timely contribution to this much discussed problem.

The last part of the book contains a full mathematical presentation of the interaction of an univalent atom with a diatomic molecule, according to the method of Eyring and Polanyi (Chapter XVI). The approximate character of the calculations is made clear to the reader. The following chapter is devoted, as said above, to the problem of interaction of many electrons dealt with by the methods of molecular orbitals and localized pairs. The book ends with a mathematical appendix with examples of computation (Chapter XVIII).

It is impossible in the short available space, to review the various interesting topics dealt with in the book.

The outstanding feature of the book is that it gives full and precise information about the modern theory of molecular and intermolecular structure. As compared with the well known monograph by Pauling the book reviewed here is dealing with a much larger scope of topics and is emphasizing the mathematical side of the subject. One of the merits of the book is that the theory is being treated in an elaborate manner up to numerical examples and is in this respect very useful to students specialized in theoretical chemistry. However, the mathematical language used by the authors from the onset, will undoubtedly present serious difficulties to the general chemical reader, wishing to form himself an idea of the nature of the chemical bond, in plain general terms, before plunging into the intricate details of the mathematical equations. For this category of readers the monograph of Pauling and the book of Wheland on resonance may be recommended as a necessary preliminary introduction.

The book written by J.K. Syrkin and M. E. Diatkina will be especially appreciated by physicists wishing to acquaint themselves with the modern trends in structural chemistry. For them the presentation of the subject will be easily understandable throughout and mostly elementary. The wealth of valuable information contained in the book not only gives it the character of a useful compendium, but is stimulating further research by suggesting new problems.

The authors are considering mainly the static side of structural chemistry. The connection between structure and reactivity of the compound is only episodically touched in the book. It must be confessed that a quantum mechanical treatment of this problem is at its very beginning and could not be incorporated into the volume intended as a text-book.

The reviewer cannot omit to mention the vigour of the style, which imparts a peculiar flavour to the book.

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