

Surprisingly, too, there appears to have been only slight appreciation of the technique of using a single aerial for transmission and reception. Such notable advances as the 'plan position indicator', used for forming a 'radar' map, seem also to have been missed.

The part of the book dealing with the elementary principles of radar will be of most interest to readers other than radio engineers. The treatment is simple and lucid, though rather sketchy. In particular the effect of the earth on aerial polar diagrams is very fully dealt with.

The main defect of the book is its complete lack of photographs. One gets a much better idea of the state of technical development from a photograph than from a bare circuit diagram. The performance of radio equipment in the ultra-high frequency region depends so much on engineering technique and layout that very little impression of the quality of the equipment can be obtained without a picture. There is a vast gap between a schematic idea and a finished operational equipment. There is little to indicate that that gap was often filled.

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## INFRA-RED AND RAMAN SPECTRA

Infra-Red and Raman Spectra of Polyatomic Molecules

By Prof. GERT HERZBERG. (Molecular Spectra and Molecular Structure, Vol. 2.) Pp. xiii + 632. (New York: D. Van Nostrand Co., Inc., 1945.) 9.50 dollars.

IT is now becoming more widely realized that infra-red spectroscopy has grown into a powerful new method for analysis and structural diagnosis, and as such it must be used by many who have hitherto had little knowledge of either the relevant theory or the experimental technique. To this extent any new book on the subject will be studied with interest. Prof. Herzberg's new monograph on polyatomic molecules, like that on diatomic molecules preceding it, is an admirable one. It is important, however, to understand just what this book sets out to cover, since in spite of its very great value it cannot, taken alone, be regarded as a manual for new workers in the field.

Until about ten years ago, most infra-red measurements were directed at the elucidation of spectral theory and the determination of molecular structure. The large number and arrangement of the energy-levels of even the simplest polyatomic molecules are far more complex than with diatomic molecules, and the selection rules which determine the possible transitions between the levels are also more involved. If it is possible to derive the energy-levels from the spectral data, important structural properties such as the moments of inertia and vibrational frequencies are obtained, and even a partial analysis may provide enough information from which many of these quantities can be determined. For such analyses, and particularly in the assignment of vibrational frequencies, a correlation of the infra-red spectra on one hand and the Raman spectra on the other may be not only valuable, but essential, if a complete solution is to be reached.

The present book provides the most exhaustive and polished discussion of these matters yet published, and is amply illustrated by many examples of molecules which have actually been studied. As is well known, the symmetry properties of molecules play an important part in determining not only the

arrangement of the molecular vibrational and rotational energy-levels, but also the selection rules. Prof. Herzberg has wisely devoted much care to a lucid account of characteristics of symmetry, with excellent illustrative diagrams. There is a thorough account of the nature of the potential energy function for molecular vibrations and of the methods for calculating the vibration frequencies in terms of the nuclear masses and force field within the molecule. Experienced spectroscopists will welcome this lucid survey of a highly complex problem, and will agree about the clarity with which the author has prepared it. There follows a detailed account of internal torsional motions, inversion doubling as found with ammonia, the relationships between the vibrational frequencies of isotopic molecules, and other related matters, and there is a valuable compilation of the results for most molecules so far examined.

The rotational fine structure associated with different kinds of vibration band is then considered by reference to molecules in different symmetry classes, and complications resulting from interaction between molecular vibration and rotation are considered in some detail. Here, too, the book will be regarded as a work of reference for many years to come. For molecules with somewhat larger moments of inertia where the rotational fine structure of the vibration bands cannot quite be resolved, the envelope of the structure can frequently be useful, and the possible types are briefly mentioned.

In a final short chapter, some applications are considered, and the methods of computing thermodynamic functions from spectroscopic data are summarized. The bibliography and index are good.

In all the above connexions, which really involve the various problems of molecular dynamics, there can be little but praise for the thorough way in which the author has set out the work, and any reader who wishes to understand the fundamental principles of the subject could find no better guide. On the other hand, the emphasis seems now to be passing to the more chemical applications, where more complicated molecules are involved. As a rule these molecules possess no symmetry, have large moments of inertia, and can be examined only in the liquid or solid state. At present, interest centres for the most part on the correlation of vibrational spectrum with the presence of internal molecular groupings, and such correlations can only be made by a semi-empirical method of comparison using related groups of molecules. There is now reason, moreover, to hope that more can be learnt from the spectra of solids and liquids about the intermolecular forces, and the technique is being applied successfully in the study of crystals and macro-molecules. The molecular dynamics of long-chain molecules, too, introduces a somewhat different problem from those considered earlier. These newer aspects are treated only briefly in the present book, which may in this respect therefore be less directly useful to the technologists. There is also little mention of the whole new field of infra-red analysis, nor any account of the experimental methods which have so rapidly improved during recent years.

These omissions do not at all affect the masterly presentation of the particular topics with which the author has dealt. Indeed, it may be that to lengthen the book would have been a disadvantage. Certainly all spectroscopists will want to refer to it, and many will regard it as a close companion.

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