Neutron scattering

Neutron Scattering in Chemistry. By G. E. Bacon. Pp. 186. (Butterworth: London and Boston, Massachusetts, 1977.) £12.50.

In writing this book, Professor Bacon has attempted a very difficult task. It is difficult firstly because any technique is likely to be able to contribute to many different branches of chemistry and secondly because neutron scattering is several techniques rolled into one. On the one hand, it is a structural tool and so immediately embraces the whole range of structural work on condensed matter including crystallography. In addition, however, the magnetic dipole moment of the neutron makes possible the study of magnetic structures and hence the determination of unpaired spin densities. On the other hand, it is also a spectroscopic technique because the low energy of neutrons of wavelength comparable with molecular dimensions makes possible an energy analysis of scattered neutrons so as to reveal details of atomic and molecular translational, rotational and vibrational motions. It is this unique ability to probe explicitly the time-dependent structure that makes neutron scattering so powerful. The range of problems which can usefully be studied, however, is always limited by the available neutron fluxes.

For many years, it has been possible to study relatively complex structures but when the fourth dimension of energy analysis is added the flux determines the practicable energy resolution and therefore the complexity of the problem which is amenable to study. A major advance in this respect was provided by the advent of the latest generation of high flux reactors within the past few years, and in particular the unique instruments at the Institut Laue Langevin, Grenoble. It is unfortunate that the timing of this book is such that only a very little of this exciting new work could be included.

Professor Bacon (a Professor of Physics) has attempted to give a brief (~ 180 pages) and essentially qualitative description of some of the results of applying neutron scattering techniques to various areas of chemical interest. It is a book in which to find a summary of some of the things which have been or can be done using neutrons, rather than a detailed description of the underlying theory or of the chemistry. For the reader who wishes to pursue a topic to a greater depth, there is a general bibliography of neutron scattering texts and conference proceedings and a list of references with each chapter.

The first two chapters contain good, succinct descriptions, respectively, of the Principles of Neutron Scattering and Experimental Methods. Three chapters follow on crystallographic studies (Structural Studies, Direct Methods, and Correlation of X-Ray and Neutron Data: X–N Syntheses) which contain some well-chosen examples of recent work. A brief chapter on Studies of Biological Materials contains a timely discussion of small angle scattering methods, but it is surprising to find no mention of specifically chemical applications of these techniques, such as the important studies of polymeric materials. Two further chapters complete the discussion of crystal structure investigations; the first (Measurements of Covalency) is concerned with magnetic scattering and the second with both Bragg reflection and diffuse scattering studies of Defects and Non-Stoichiometry in a variety of crystalline phases.

In all of the above, as well as in the structual aspects considered in the last chapter on Liquids, Glasses and Gases the treatment is clear and authoritative. The two chapters not so far mentioned are entitled Molecular Spectroscopy and Polymers. Here, the treatment is less satisfactory partly because, as mentioned earlier, it is in these areas where marked advances have very recently been made, since the availability of high resolution spectrometers. Nevertheless, this does not account for all the omissions: for example, there is no discussion of quasielastic scattering from molecular rotations, nor of solid-state diffusion; indeed, the treatment of quasielastic scattering does not begin to reflect the importance of this area of work (the omission of any reference to Springer's elegant 1972 monograph on the subject demonstrates the point). There should have been some mention of phase transitions and a more extensive discussion of phonon dispersion in molecular crystals. In spite of the omissions, however, this is a timely and welcome book which goes some way towards filling a serious need

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Raman spectroscopy

Raman Spectroscopy. By D. A. Long. Pp. xiii+276. (McGraw-Hill: New York and London, 1977.) £14.40.

Following the development of the laser in the early 1960s, there has been a boom in Raman spectroscopy. It is now a routine laboratory technique. This rapid progress has led to the publication of several multi-author volumes and to the *Journal of Raman Spectroscopy*. This book, however, is the first by a single author that aims to provide an "up-to-date survey of the whole subject, setting Raman spectroscopy in perspective, unifying the basic theory, illustrating the applications and potential of the technique, and guiding the reader towards the specialist literature".

There are eight chapters and three appendices. Also, there is a central reference section of sixteen blue pages containing thirteen tables of formulae for intensities and polarisation properties of Raman scattering by gases. Chapter 1 is a general introduction, a nice feature being the reproduction of the original 1928 papers by C. V. Raman and K. S. Krishnan and by G. Landsberg and L. Mandelstam in *Nature* and *Naturwissenschaften*, respectively. Chapter 2 describes the properties of electromagnetic radiation and defines the four Stokes parameters. Chapters 3 and 4 present classical and partial quantum-mechanical treatments of Rayleigh and Raman scattering. They proceed at an easy pace and include a very detailed account of the polarisability tensor. Chapter 5 is on time-dependent perturbation theory, the Placzek polarisability theory, resonance Raman scattering, and Raman optical activity. Experimental procedures are described in chapter 6 and numerous examples are discussed in chapter 7. The final chapter is devoted to non-linear Raman effects. Appendix I is a guide to the literature; II lists for the common point groups the symmetry classes of translations, rotations, polarisabilities and first hyperpolarisabilities; and III describes a Raman study of a crystal.

The style is lucid and the illustrations excellent (although the notation is not always attractive), so the book will be helpful to many students. It expounds at length some of the properties of cartesian tensors, and includes some very interesting and recent applications of Raman spectroscopy to problems in organic and inorganic chemistry. Some of the more physical topics, such as line shapes and Brillouin scattering from liquids, are not considered. In a few places, as in the description of magnetic and electric Raman optical activity on p131, there are errors; and the references are not always adequate (for example, the four references at the end of chapter 3 and those in Appendix I give no help to someone trying to understand non-linear polarisation, introduced on p41).

The book has been well produced and is good value.

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