IMAGING MECHANISMS IN THE ELECTRON MICROSCOPE

Fundamentals of Transmission Electron Microscopy

By Robert D. Heidenreich. (Interscience Monographs and Texts in Physics and Astronomy, Vol. 13.) Pp. xiv + 414. (New York and London: Interscience Publishers, a Division of John Wiley and Sons, Inc., 1964.) 109s.

IF in its first twenty years the electron microscope was largely devoted to biological applications, the past decade undoubtedly belongs to metallurgy and metal physics. Beginning with the first successful attempts to prepare samples from bulk aluminium sufficiently thin for imaging in transmission, methods of chemical and electrolytic etching have been devised for the similar preparation of almost all metals, alloys and more recently semiconductors also. It is in this context that the title of Dr. Heidenreich's book has to be read.

Although in his preface Dr. Heidenreich states the intention of providing a treatment of image formation which will be applicable to biological as well as metal specimens, in effect this stops at the atomic level so far as amorphous structures are concerned. Half-a-dozen pages are given to the imaging of molecules and elementary fibres, but larger biological units are not considered and there is no mention of the work of Lippert, Bahr, Zeitler and others on the problem of determining mass-thickness from image contrast in electron micrographs.

What the book does do, and does very well, is to set out the physical bases of electron scattering and diffraction processes, and then to apply them first to the imaging of perfect crystals and afterwards to that of actual metals, taking into account grain structure and lattice defects. Four chapters are devoted to the scattering and energy loss of electrons, four to interference and diffraction phenomena, three to discussion of the origins of contrast in electron microscopical images, and a short final chapter to the rather unrelated topic of electron probe microanalysis. The wave approach is used from an early stage, and is developed in great detail. Dr. Heidenreich sticks to his declared intention of dealing with 'fundamentals' and gives no space to the principles or the operation of electron microscopes, or even to the techniques for preparing thin specimens.

Within these limits he provides a most valuable guide to the interpretation of electron micrographs of lattice structures. The mathematical treatment is thorough and clearly presented. If the micrographs are not always well enough reproduced to bring out relevant details, the diagrams are unusually well drawn, especially those depicting three-dimensional phenomena. On the whole, the author achieves his aim of developing "a coherent, physical approach to the understanding of contrast in electron microscope images". Its chief shortcoming is the absence of any detailed account of the anomalous absorption theory of electron transmission in crystals. Dr. Heidenreich recognizes its existence but dismisses it, apparently because there is as yet no clear physical picture of some of its concepts. This is largely true, and for this reason the theory would not fit neatly into the development of contrast effects from fundamental interactions. But it has been very successful in describing a number of observed phenomena in electron images, and it would not be unusual for an empirical theory to turn out to be correct, perhaps on grounds not obvious to its original authors.

To do him justice, Dr. Heidenreich does give references to papers in which the anomalous absorption theory is set out, so that readers can study it and form their own opinions. Perhaps it is asking too much of an author to give much space to a treatment in which he does not himself believe. Apart from this omission the book is

notable for an exemplary breadth of conception and clarity of exposition. It is likely to find as much use in courses of advanced instruction as in the research laboratory.

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ELECTROMAGNETIC PHENOMENA

Natural Electromagnetic Phenomena Below 30 kc/s

Edited by D. F. Bleil. (Proceedings of a NATO Advanced Study Institute held in Bad Homburg, Germany, July 22-August 2, 1963.) Pp. vii + 470. (New York: Plenum Press, 1964.) 17.50 dollars.

THIS volume contains the written versions of lectures delivered at a NATO Advanced Study Institute held during July-August 1963. Readers who are becoming confused by the ever-increasing flow of publications which follow 'conferences', 'courses' or 'study groups' will first wish to know what this volume contains which could not have been published in the normal scientific journals. To them it can be said that about one-quarter consists of valuable review articles on subjects where good reviews are needed, and scarce, and that much of the remaining material might have been published in the normal way, with more profit to the readers and to the writers, if not to the publishers.

Three review articles are particularly appropriate to the title. Lokken writes on "Instrumentation for Receiving Electromagnetic Noise below 3,000 c.p.s." and gives an excellent account of the techniques and difficulties of measuring fluctuations of the geomagnetic field in the range of frequencies from 0.001 sec⁻¹ to 10⁴ sec⁻¹. He divides the techniques into those useful in the micropulsation band with frequencies less than 5 sec⁻¹, in the low E.L.F. or Schumann band between 2 and 50 sec⁻¹, and in the band above about 50 sec⁻¹. Magnetometers described include those which make use of proton precession and optical pumping, and those which use the flux gate principle. Galejs, writing on "Terrestrial Extremely-Low-Frequency Propagation", gives a fairly detailed account of the theory of the propagation of waves in the Earth-ionosphere cavity and compares the results with those from experiments. Gallet gives a theoretical account of the production of those V.L.F. emissions which do not arise from lightning flashes. He first outlines some of the simple theoretical ideas which might account for the emission of these radiations through the interaction of incident beams of electrons with electromagnetic waves in the ionospheric or magnetospheric plasma. He then shows how this theory can be extended to include some of his more recent ideas.

Of the other review type articles the one by Axford on the nature of the magnetosphere and the one by Sugiura on "Geomagnetic Storms" will probably be found most interesting. It is a little difficult to see why they should appear in a book with the present title, and it is perhaps unfortunate that they have not been published somewhere else where they will be more widely read.

Other reviews, by McNish on the aurora and by Gibbons on the ionosphere, seem unduly restricted. In spite of the title, McNish writes mainly about geomagnetism and Gibbons about the propagation of radio waves in the ionosphere, but he restricts his treatment to ray methods, and to frequencies greater than 150 kc/s, which seem to have little relevance to the present volume.

Most of the remaining papers, not of the review type, could have been published in the normal way. There are experimental papers on natural emissions at high latitudes in the frequency range 500-1,000 sec⁻¹ and on observations of micropulsations, including some at conjugate points. Alfvén and his collaborators discuss their recent suggestions that the usual magnetospheric model needs essential modification. There are interesting papers on geomagnetic effects caused by high-altitude nuclear explosions