

Book Review

The Mobility and Diffusion of Ions in Gases. By Earl W. McDaniel and Edward A. Mason. Wiley-Interscience Publishers, Inc., New York (1973). 372 pp. \$22.50.

The conduction of electricity through gases has been a subject of interest to scientists for well over a century. It led directly to the discovery of x rays, indirectly to the discovery of natural radioactivity, and to the existence of the electron and atomic structure. After all this time, one might think that a set of basic quantities such as the diffusion and mobility coefficients of ions in gases would be well known and one would simply be firming up the third place in their numerical values. Such is not the case, as McDaniel and Mason point out. Quoting from their preface, "Experimentation in this field is difficult, . . . and . . . few mobility data obtained before 1960 are of more than historical interest today." Nevertheless, an accurate knowledge of these coefficients is as important as ever. Weakly ionized plasmas still play a key role in electronics, in the atmosphere, and in other commercial applications; and even the hoped-for fusion reactors will have plasmas outside of the central regions of these devices in a state amenable to analysis by these methods. Thus the authors have addressed themselves to an excellent goal, that of preparing a statement of what is known today about both the experimental and theoretical aspects of the mobility and diffusion of ions in gases.

How well have they succeeded? In large measures, very well. There is excellent discussion of modern experimental technique, with elaborate description of modern drift tubes, emphasizing the importance of mass-spectrometry in distinguishing between the various species of ions. Attention is paid to the effects of chemical reactions between ions and to afterglow techniques. The theoretical sections amply deal with the most advanced research results, and it is very useful to have careful comparison made between the several techniques in vogue. Discussions such as those illustrated by the diagram on p. 145, showing the relations between various methods of solving the Boltzmann equation, are to be applauded. I was impressed by the detail given on improved approximations for the mobility, including

extensions of the theory to include larger values of E/N , gas mixtures, charge exchange, and ion transfer.

If there is any fault in the book, it lies with the elementary theory. At times, the authors seem too eager to get on to advanced ideas and hurry through the elementary development. In their preface, McDaniel and Mason suggest that the audience for which the book was written includes scientists and engineers working in this area, graduate students entering the field, and researchers in related fields. I think the first and last are well-served, but I fear the early theoretical treatment is too thin for a graduate student. I would certainly recommend that a reader come well prepared in the elementary aspects of transport theory.

All in all, this will certainly be a useful text. This is assured by the last 80 or so pages, which summarize experimental information on various ion diffusion and mobility coefficients. Even without this, the book should become an important reference text in the field for many years to come.

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About the Reviewer: Albert Simon's interest in and contributions to plasma physics are of long standing, dating from his association with the fusion project at the Oak Ridge National Laboratory in the 1950's and his subsequent direction of the Plasma Physics Division at General Atomic. Dr. Simon's academic training was at the College of the City of New York, followed by graduate studies at the University of Rochester where he now holds a Professorship in Mechanical and Aerospace Sciences. He is currently on sabbatical at the Institute for Advanced Study, which will be followed by a Senior Visiting Fellowship at Oxford. His research interests are in the nonlinearity of plasma instabilities and their application to the behavior of plasma in fusion experiments and in barium clouds of the ionosphere.