operation of ion-exchange purification of proteins will be especially useful to readers in industry.

Aside from a few sentences that could have been edited into more conventional modern English, the book is clearly and carefully written.

The field of biochemical separation and purification, rich in complexity and opportunity, is rapidly developing and changing. Books such as this one, provide useful benchmarks for understanding and evaluating the state of the art, and for monitoring the frequent changes.

Benjamin J. McCoy
Dept. of Chemical Engineering
Univ. of California
Davis, CA 95616

Transport Properties of Ions in Gases

By Edward A. Mason and Earl W. McDaniel, John Wiley and Sons, New York, 1988, 560 + xvi pp.

This monograph is largely an updated version of an earlier book by the same authors (McDaniel and Mason, 1973). Both works are surveys of experimental and theoretical treatments of the transport of ions in neutral gases under the application of an electric field. The main motivation for the new book (not a second edition) is to detail the advances that have taken place in the kinetic theory of ion transport in gases since 1975. In addition, several new experimental techniques are described along with updates of traditional methods. The intended audience appears to be scientists and engineers with interests in gas discharge phenomena (e.g., plasma chemistry and gas discharge lasers); atmospheric and interstellar ionic phenomena; ion-neutral chemistry; and in general, any application in which ion-neutral collisions at energies below about ten electron volts, are important. Chemical engineers involved with plasma processing of electronic materials, combustion, or atmospheric chemistry fall into this group.

The transport coefficients of interest here are the mobility (ratio of ion velocity to electric field strength) and diffusivity. The mobility is a scalar, but diffusivity is in general a tensor. This is because the diffusion coefficient parallel to the applied electric field is not equal to diffusivity in the perpendicular direction, which is related to a corresponding anisotropy in the ion velocity distribution. The general goal of ion transport theory is to relate the macroscopic transport coefficient to molecular properties (i.e., the interaction potential) of the ion and neutral involved.

The first chapter is a phenomenological treatment of ion transport with key concepts and definitions presented. Chapters 2 through 4 (about 100 pages) cover experimental methods, mainly drift tubes and afterglows. In a drift tube, ions are released repeatedly in pulses from one electrode, and drift to another at which they are collected. Afterglows can be either stationary (the electric field sustaining a discharge is turned off and time decay of ion density reveals rate and transport coefficients) or flowing (a rapidly flowing gas traverses a discharge, and density is measured as a function of position downstream from the discharge). Both techniques have been employed for many decades to measure electron rate and transport coefficients (e.g., Huxley and Crompton, 1974); application to ions has been more recent (since the early sixties) because ions tend to react with the background gas and change identity.

Chapters 5 through 7 (300 pages) form the heart of the book, covering the kinetic theory of ion transport (Chapter 5); applications of kinetic theory to predict transport coefficients (Chapter 6); and the use of ion-neutral interaction potentials (Chapter 7). The authors initially emphasize a physical description of the concepts underlying kinetic theory of ion transport, with a progressively more mathematical treatment later. I find this section to be the most complete, readable and insightful discussion of charged particle transport that I have come across. The fundamental differences between classical neutral gas transport theory, electorn transport, and ion transport are clearly described. The essence of the difficulty with charged particle transport theory is that the traditional perturbation/expansion methods (Chapman-Enskog) rely small deviations from local equilibrium. Unfortunately, with even quite small electric fields, electrons and ions begin to deviate substantially from local equilibrium with the neutral gas. As a result, the expansions fail to converge under conditions of interest. Electron transport theory can effectively exploit the small ratio of electron to neutral mass: this leads to nearly spherically symmetric velocity distribution functions, and expanding the distribution function in spherical harmonies therefore converges rapidly. For not too large electric field to gas number density ratio (E/N), electron velocity distributions tend to be nearly isotropic, but not, in general, Maxwellian. Ion velocity distribution functions tend to be highly anisotropic, and modern theories rely on methods that focus on the velocity moments of the ion distribution function rather than the distribution function itself. The velocity moments are, of course, of greatest interest macroscopically, as they are directly related to drift velocity, mean energies, diffusivities, etc. The key step is based on a rather standard technique in physics: represent the solution in the form of a basis function expansion with the basis functions made orthogonal with respect to some weighting function. The trick is to properly choose the weighting function and basis functions, and much discussion is provided for the choices that have proven successful for ion transport.

The eighth and last chapter is an abbreviated collection of some applications of ion transport and kinetic theory. This chapter is the weakest in the book, but is intended to give only a flavor and an introduction to the literature for some selected subjects. It does not detract significantly from the book's strengths.

Finally, an index to the literature containing original data is provided in an Appendix, as are several other tables of useful quantities (cross sections for model potentials and parameters for ion-neutral interaction energies). In addition, literature citations throughout the book appear to be unusually thorough. I anticipate that this book will become a standard refverence for ion transport in gases. It will certainly be useful to chemical engineers interested in plasma chemistry and gaseous electronics, and I wholeheartedly recommend it to anyone interested in the subject.

Literature cited

Huxley, L. G. H., and R. W. Crompton, *The Diffusion and Drift of Electrons in Gases*, John Wiley, New York (1974).

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David B. Graves
Dept. of Chemical Engineering
Univ. of California, Berkeley
Berkeley, CA 94720