lish-speaking readers. In particular, note of the relation between the "linear conductivity" and the well-known invariants would have been appreciated.

I will certainly place this book on my personal reference shelf for occasional background reading, not for use as a "working text." For students, I would suggest the same, but could not suggest the book as a basic text. A few of the explanations are of questionable value when aberration magnitudes close to the diffraction limit are being discussed. The author, however, clearly understands his subject, and I find no substantive errors on a first reading.

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Electrochemical Tools

Ion-Selective Electrodes. Proceedings of a symposium, Gaithersburg, Md., Jan. 1969. RICHARD A. DURST, Ed. National Bureau of Standards, Washington, D.C., 1969 (available from the Superintendent of Documents, Washington, D.C.). xxii, 458 pp., illus. $3.50. NBS Special Publication No. 314.

In the face of the rapid increase in the availability of "ion-selective" membrane electrodes, a complete and judicious evaluation of their properties and uses, free of hucksterism, would be very welcome. This symposium volume comes close to filling the need, and it can be widely recommended to physical and analytical chemists, clinicians, and geochemists and as material for classroom use. The only flaw arises from the excess of enthusiasm that accompanies an expanding technology.

Membrane electrodes in the form of *p*H-sensitive glass electrodes have been in use for half a century; others, such as AgCl and Na-sensitive glass electrodes, have been known for almost as long. During this time, despite the general use of the glass electrode for practical *p*H measurements, membrane electrodes have been little used for analysis and in basic thermodynamic studies. This neglect probably resulted from lack of understanding of the electrode mechanisms, from the restricted range of available types, and from limited acceptance of activity measurements for ions other than hydrogen. That this situation is changing is due in large part to the efforts of authors of this book.

George Eisenman, who revived interest in alkali-ion sensitive glass electrodes, contributes a discussion of the mechanism of various liquid- and solid-membrane electrodes. This paper may stimulate new electrode research as well as providing a basis for understanding the limitations of existing electrodes. James Ross discusses the newer electrodes that he and his colleagues at Orion Research have developed. Unfortunately, liquid junction effects have been omitted from his discussion of electrode precision and the exponent Z_B/Z_A in equation 3, page 64, is upside down. There is, however, much information here that is not available in company literature or in earlier reports.

The discussion of reference electrodes by Arthur Covington and of thermodynamic studies by James Butler are very well done and will serve to introduce the discipline of electrochemistry to readers in other fields. The paper on activity standards by Roger Bates and Marinus Alfenaar has been needed, although I cannot agree with their rejection of the MacInnes convention for single-ion activity coefficients. It is unlikely that *p*Ion scales other than *p*H will ever be widely used; however, this paper produces much of the basis for such scales.

The last part of the book is devoted to specialized studies that may serve as models for the application of electrodes in diverse fields. The absence of a discussion of the interesting clinical uses of alkali-ion sensitive glass electrodes is regrettable, but the description of comprehensive clinical studies with Ca++-sensitive electrodes by Edward Moore is an excellent introduction to the methods.

This book is sure to interest and may stir the imaginations of workers in many fields.

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Astrophysical Data

Stellar Spectroscopy. Normal Stars. MARGHERITA HACK and OTTO STRUVE. Osservatorio Astronomico di Trieste, Trieste, 1969. iv, 204 pp., illus. $6.

A more extensive version of this book was to have been published in 1963; the death of Struve, the then-senior author, altered the plan. The junior author then reduced the book to one-half its size and has separated it into four sections, of which this is the first. The stated objective is to give graduate students an introduction to the main results of stellar spectroscopy. The authors have a gift for posing fundamental problems, and in the reviewer's opinion this is one of the chief values of the book. If their objective was to send the graduate student to the literature for the details of a given problem the authors have succeeded. More synthesizing and evaluation of the results from two such eminent astronomers also would have immense value, however, and in this respect the book falls short. The often sketchy review of the techniques and results is somewhat offset by the extensive bibliography; 335 references, many of which are multiple, are given, the latest of them published in 1968. A number of recent significant papers have been omitted, however. The most notable defect, oddly, is an overabundance of diagrams (over 75). Many of the diagrams are needlessly repetitive, and others are confusing, with the key to complete understanding in the original reference (the reviewer defies the uninitiated to understand fig. 22a of chapter 2).

In the first chapter fundamentals such as atmospheric extinction, sources of scattering, and emissivity are discussed. The general approach to inductive and deductive analysis of stellar atmospheres is then outlined. Next is a review of the major spectral and luminosity classification schemes and a comparison between observation and theory. The classical "spectroscopic parallax" method is not mentioned directly, but several specialized aspects of it are discussed. The spectrum-luminosity diagram shown for 6700 stars is outdated and gives an erroneous concept; it should have been omitted. There are several complete and detailed reviews of spectral and luminosity classification and calibration that are not mentioned in the text or bibliography.

Stellar rotation is treated clearly but not completely. The observed and predicted frequency distributions of $v \sin i$ for various spectral and luminosity classes are nicely illustrated. The detection of macroturbulence also is included. A field pioneered by Struve, the study of stellar rotation as evidenced by the distortion of the radial velocity curves of eclipsing binary systems just prior to and following primary minimum, is mentioned only in passing. Presumably it will be discussed in detail in Part IV.

In the final chapter the review of the methods for abundance determination is straightforward, but again only summarizes the approaches. The discussion of derived stellar abundances and correlation with age and location is stimulating and should suggest to the young researcher a fertile field for research.

The overall reaction to the book is that the reader cannot fail to leave it without a head full of new ideas; it should be particularly valuable to graduate students, but even the established observational spectroscopists should include this work in their libraries.

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A Kind of Microscope

Field Ion Microscopy. Principles and Applications. ERWIN W. MÜLLER and TIEN TZOU TSONG. Elsevier, New York, 1969. x, 314 pp., illus. $19.

"The fascination of field ion microscopy lies in the immediacy of the encounter with the individual atoms making up the real surface structure of solids. The uniquely powerful field ion microscope is so basically simple that it is hard to understand why . . . its acceptance as a research tool required a relatively long initiation period." To the first of the authors of this text, Erwin Müller, goes the honor of inventing what is, at one and the same time, both the simplest and the most powerful microscope. To see atoms with a microscope (containing neither lenses nor light source!) that is well within the constructional skill of a junior high school science club bespeaks an unusual elegance of conception. It is indeed pertinent to ask why the field ion microscope remains, even today, a fascinating demonstration of crystal regularity rather than a powerful research tool comparable to the electron microscope or the x-ray diffraction camera.

Müller's contribution to field ion microscopy extends far beyond the accident of invention, and his innovations range from the initial discovery of the technique, in 1951, through the introduction of cryogenic techniques (1956), to image intensification (1963) and, finally, the atom probe for detecting and identifying individual atoms (1968). The present text is the long-awaited summary of all work up to September 1969 on field ion microscopy. That the emphasis is on the research carried out by Müller's laboratory, at Pennsylvania State University, is more a reflection of the vast volume of results produced by this one laboratory rather than of any bias on the part of the authors. Indeed, they have taken pains to include any and all work from every source, and have been most critical of their own published papers and perhaps a little too kind in evaluating the work of others.

The authors go a long way toward explaining just why the simplicity of field ion microscopy is largely deceptive, and the reader with a background in modern physics may be forgiven for some astonishment at the naivety of much of the past thinking in this field. Explanations for the basic processes of field ionization, field evaporation, and field etching remain unsatisfyingly crude, and the good agreement with experiment seems unconvincingly fortuitous. Much the same can be said for the calculation of image intensity, contrast, and resolution.

The present text emphasizes experimental research on the field ion microscope itself, and by contrast the section on applications makes unsatisfactory reading. The reason for this dissatisfaction lies in the relative rarity of attempts to use field ion microscopy as a tool to solve a particular research problem or to provide basically original information. Instead, the known structure, properties, and history of the specimen are repeatedly invoked by the authors to explain, for the most part qualitatively, details of image contrast, and the reader is left with the impression that this correlation process is regarded as the end product and satisfactory conclusion of a field ion microscope investigation. In summary, this book is now the definitive text on the principles of field ion microscopy, but the microscopist will find little here to convince him that this technique can ever become a routine research tool.

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