a compromise hypothesis might be useful. This is duly presented, with the warning that "it will undoubtedly be vigorously rejected by both opposing parties."

Although the title of this book implies that mitochondria and chloroplasts will be equally represented, chloroplasts are considered only briefly in a single chapter. Also, much of the work is unavoidably at least two years old and the material of several chapters has since appeared elsewhere in revised form.

All in all, the book will be a useful reference for several years. It bears the clear stamp of a unifying editorial effort. The chapters are organized along similar lines of presentation, and the electron micrographs and illustrations are for the most part quite clear. The present utility of the book is suggested by the fact that this reviewer had to retrieve his copy several times from graduate students and colleagues who found it to be a highly readable current review of the field.

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## Terpenoid Biochemistry

**Natural Substances Formed Biologically from Mevalonic Acid.** Biochemical Society Symposium No. 29, Liverpool, April 1969. T. W. GOODWIN, Ed. Academic Press, New York, 1970. viii, 186 pp., illus. $8.

This symposium brought to Liverpool a small group of major contributors to areas of the terpenoid field which have seen important recent progress. The meeting was therefore timely, and the resulting volume, though selective, encompasses some of the most significant current topics in terpenoid biochemistry.

Several contributions illustrate the extensive recent use of stereospecifically labeled mevalonic acids in studies of isoprenoid biosynthesis, and, appropriately, the Cornforths review their original work on labeling methods which provided the impetus for this approach. Unfortunately, its application, together with nuclear magnetic resonance spectroscopy, mass spectrometry, and expert enzymology, to the enigmatic $C_{30}$ precursor of squalene, as recounted by Popják, has so far failed to give an unequivocal answer to this challenging structural problem.

The stereospecific labeling approach is exemplified in Hemming's account of the polyprenols and in Goad's survey of advances in sterol biosynthesis. The latter author performs sterling service in summarizing a literature which is confusing, not so much for its biochemical complexities as because of the considerable overlap of recent efforts by different workers, all riding the stereochemical wave.

The enzymology of the separate processes of squalene oxidation and cyclization to lanosterol is discussed by Yamamoto and Bloch. Their efforts and those of others notwithstanding, the mechanisms of these transformations of squalene remain elusive. So also does the precise mechanism of participation of terpenoid quinones in oxidative phosphorylation, despite the accumulation of an impressive body of detailed knowledge presented by Brodie and co-workers. The distribution and comparative utilization of quinones (Wiss and Gloor) and their biosynthesis (Rudney) are also authoritatively surveyed. The book is therefore a valuable comprehensive source of recent information on these compounds.

Karlson reviews the biochemistry of the ecdysones, juvenile hormones, and the terpenoid pheromones and defensive substances of insects and touches upon the intriguing discovery, by Schildknecht and collaborators, of defensive steroids of the mammalian hormone type in water beetles. Since comparative biochemical knowledge in this area is sparse, Karlson's view that these insects have "invented" the route to these compounds quite independently of mammals seems less obvious than he asserts. Indeed, an additional contribution to this symposium might profitably have come from a steroid phytochemist, who would have shown that such steroids participate in many biogenetic sequences in plants.

The final paper, by Battersby, deals with his biogenetic studies of indole alkaloids, in which the pivotal intermediary role of loganin has recently been established and exploited. This elegant blend of organic chemical and biochemical intuition and expertise is in the best traditions of the field and well illustrates its interdisciplinary character as expressed in Morton's opening remarks.

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## Optical Systems

**Geometrical Optics.** HANS-GEORG ZIMMER. Translated from the German edition by Raymond Wilson. Springer-Verlag, New York, 1970. viii, 172 pp., illus. $9.40. Applied Physics and Engineering, vol. 9.

The author begins with a theory of geometrical optics based upon a law for the conservation of energy passing through the optical system rather than upon the law of refraction. Since both are consequences of minimal principles, the resulting conclusions are of course the same. The interesting point is that the development in this book bridges a gap that is perhaps even unanticipated by the author. In the design of energy-collecting and image-detecting instruments, principally in the infrared region, the "throughput" has come to be used to characterize the overall light-collecting efficiency of a lens system. This "throughput" turns out to be a general form of the Lagrange invariant familiar to all optical designers. This is identical to the "linear conductivity" used by the author in this book as the basis for his development of geometrical optics. All the usual paraxial laws are easily derived, and the author includes a useful observation on the comparison of his linear conductivity with the wavelength to describe the extent to which a system can be described on a geometrical rather than physical basis.

The author provides some examples of magnitude of the linear conductivity of energy and applies his approach to some common systems. He also shows how his approach is a generalization of the $y$-$\bar{y}$ approach to system analysis proposed by Delano. This closes part 1 of the book, which is quite useful and instructive.

Part 2, on aberrations, begins well with a discussion of optical materials and chromatic errors, but is burdened with an awkward, unconventional notation that becomes increasingly difficult to follow. The various chapters on aberration are laced with descriptions of actual problems in design that are quite worth reading, but the formulas developed are cumbersome to work with.

In total, this book is a useful contribution to the literature. Part 1 is suggested for general interest, part 2 for the specialist. The book is not a manual for design, nor did the author intend it to be so.

It is unfortunate that the translator did not take the opportunity to insert a preface relating some of the concepts and notation to forms familar to Eng-

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.