particularly in conjunction with the companion volumes. In spite of any resemblance to the sort of symposium proceedings that can be characterized by rapid obsolescence, this book is not only a review of a historically completed event (of a type which, by definition, cannot be repeated for several years) but is also a summary of phenomena so new and undigested that meaningful inferences and new research ideas may yet result from their further examination.

The distinction is not made in the text, but I shall separate the papers into lengthier reviews and briefer commentaries or topical notes. The first review, by H. W. Dodson and E. R. Hedeman, sets the stage with a detailed discussion of the 1964–65 history of solar activity in the traditional terms of sunspots, plages, flares, and related phenomena. In particular, the development of major centers of activity is followed, and their phenomenology with regard to solar coordinates and the locations of earlier centers is thoroughly presented. This basic study is followed by an informative introduction to solar soft x-ray emission (H. Friedman) and by several classic reviews. One on the solar wind (E. R. Mustel) discusses interplanetary streamers, illuminating the distinction between the R disturbances from active regions and the long-lived M disturbances; one on magnetic fields and plasmas (N. F. Ness) details the measurements and presents a comprehensive picture of the macro- and microstructure of the interplanetary medium.

Papers on cosmic rays review experimental results from sea-level neutron and meson monitors (H. Carmichael) and from space vehicles (F. B. McDonald), and the theory of time variations (L. I. Dorman) follows. In the first one (notwithstanding a mislabeling in figure 7 of the 23 September decrease, found by U. Desai), the ramifications of ground-based synoptic observations are rigorously reviewed. The results are illuminating (it would take extreme confidence to trust one's results with time-varying corrections of over ten times the amplitude of the sought-after effect). The next outlines the advances in the study of low-energy galactic and solar cosmic rays made possible by the continuous time coverage and the great sensitivity to low-energy particle populations that have been attained by spacecraft. A variety of non-flare solar particle emissions that occurred during or near solar minimum are also mentioned. This paper and a companion note discussing solar modulation of cosmic rays (W. R. Webber) both mention the improvement resulting from the use of the *Ap* index (which is directly related to the solar wind and to the interplanetary field), rather than sunspot number, as a coordinate for the description of particle behavior in the solar cycle. The third review, of time variations, is extensive, but one gets the feeling that it is unnecessarily out of date in the choice of parameters it seeks to explain.

In the next review, S. N. Vernov optimistically predicts that the entire problem of the trapped radiation zones will be solved in the very near future. Although the optimism may be unwarranted, the article seems valuable. In a related note, C. E. McIlwain presents the counterpoint that most theories may be speculations having little correspondence with reality, but nonetheless he outlines a possible mechanism of particle acceleration in the magnetosphere. The last review paper is on the phenomenology of auroras (Ya. I. Feldstein, S. I. Isaev, and A. I. Lebedinsky). It appears to be well done and comprehensive, and contains an impressive bibliography.

The book includes several more compact notes by various workers. In many of these the observational sophistication of the last decade is clear, but the lack of detailed theoretical understanding beyond the conjectural or ball-park stage is also evident. In general, the presentations, being mostly self-contained summaries with little cross reference, provide a many-parametered and disjointed picture of solar-terrestrial physics. This is not a failing of the authors but an accurate portrayal of the existing state; the integration of these disciplines into one coherent picture is yet to occur. Many basic phenomena involved, such as the solar-flare and solar quiet-time particle emission processes, the modulation of cosmic rays and the creation of particle populations in the trapped radiation, are yet to be understood. This book presents us with an excellent summary of the last solar minimum—a fragmented phenomenology, but an orders-of-magnitude improvement over the pictures from previous solar cycles.

THOMAS L. CLINE
High Energy Astrophysics Branch, Goddard Space Flight Center, Greenbelt, Maryland

Electrons and Electrodes

Tunneling Phenomena in Solids. Lectures presented at a NATO Advanced Study Institute, Risö, Denmark, June 1967. ELIAS BURSTEIN and STIG LUNDQVIST, Eds. Plenum, New York, 1969. x + 582 pp., illus. $35.

The tunneling of electrons or other particles through a potential barrier is a purely quantum-mechanical phenomenon having no classical analogy. Research on tunneling, however, does have a classical analogy: cooking. In most cases the skill of the chef is more important than the quality of the ingredients—every chef has his own secret recipes—and the final result frequently ends up in the garbage. It was with great anticipation that I received this volume, hoping it would be the badly needed "cookbook" of the field. Alas, it is not, although it does contain some interesting recipes.

A glance at the table of contents of this volume suggests that the material covered is as diverse as the title would suggest; topics listed range from atomic tunneling in solids to quantum interferometry using Josephson junctions. Upon more careful examination one discovers that, except for a cursory article or two, most of the book deals with electronic tunneling between two electrodes. The first half contains sections on general tunneling theory and on semiconductor Schottky and *p-n* diodes, with several chapters devoted to phonon-assisted tunneling. The second half is devoted primarily to metal-insulator-metal junctions, with the preponderance of the authors discussing superconducting tunneling of one type or another. There is also an excellent section of related papers, both experimental and theoretical, on the Josephson effect. The organization of material, however, serves to emphasize the diversity of the subject matter rather than its underlying unity.

This is the only published compendium of the developments of the field (up to 1967) in which the developments are described by the original researchers. Many of the chapters present valuable insights, experimental techniques, and a variety of warnings against repeating the mistakes of others. For these reasons alone, this book should be on the shelves of those who are either considering working in the field or seeking applications of tunneling junctions and devices to other problems.

The casual reader, however, who approaches this volume for the purpose of obtaining an overall view of a rather diversified field with a multitude of both potential and realized technological applications may experience some difficulty in trying to put things in perspective. Although some attempt has been made to collect similar topics into adjacent chapters, the arrangement is rather haphazard and lacking in logical continuity. In addition, as with so many symposium volumes, many topics are discussed but each segment tends to be too narrow and specialized. There is no general review article to tie the subjects together. Reference lists have been left to the individual authors to provide, and the result is a narrow and subjective selection with a great deal of overlap.

There are at present only two other books dealing with electronic tunneling, one of them restricted to superconducting junctions. Duke's *Tunneling in Solids*, a supplement to the classic Seitz and Turnbull series *Solid State Physics*, presents the entire subject of tunneling between two electrodes in a systematic, well-organized, and thorough manner while emphasizing the spectroscopic aspects and applications. It is somewhat more theoretical and up-to-date and contains a fanatically comprehensive list of references, but often lacks the particular flavor imparted by an author who is reviewing his own work. Those who are interested primarily in superconducting tunneling or the Josephson effect should also consult the several relevant sections of Parks's *Treatise on Superconductivity*, in which a more cohesive treatment of these specialized topics is presented in much greater depth.

In summary, this book, though flawed, is a unique introduction to tunneling phenomena for those who are unfamiliar with recent developments and an interesting bit of memorabilia for those who have been contributing in past years. For those who are currently engaged in research, however, Duke or Parks will be indispensable; Burstein and Lundqvist probably will not be. If you cannot afford all three books, shop carefully before purchasing; the value of each depends on the knowledge of the user.

GENE I. ROCHLIN
Department of Physics,
University of California,
Berkeley

Tetrapyrrole Biosynthesis

Porphyrins and Related Compounds. A symposium, London, April 1968. T. W. GOODWIN, Ed. Academic Press, New York, 1968. x + 176 pp., illus. $6.75. Biochemical Society Symposium No. 28.

The moderate price, coherence, and high quality of the Biochemical Society symposium volumes, published under the competent and experienced editorship of T. W. Goodwin, make them well suited for use in graduate courses, and they constitute a good source of topics for those inevitable tribal rites of graduate education—cumulative and oral examinations. This symposium honored Claude Rimington, a pioneer and long-time leader in the field of porphyrin metabolism. A few well-known workers who have been contributors to symposia and monographs in this field in the past are regrettably missing from this volume. However, another pioneer, David Shemin, makes a presentation on his recent and elegant elucidation of the mechanism of action of aminolevulinic acid dehydratase.

The title *Porphyrins and Related Compounds* might have included the word "biosynthesis," since 8 of the 12 papers are directly concerned with the nature and regulation of tetrapyrrole biosynthetic pathways in plants, animals, and microbes. A representative mix of approaches and organisms is maintained, ranging from experimental porphyria in mammals to chlorophyll formation in photosynthetic bacteria. Three of the papers cover some highly pertinent advances in the organic chemistry of tetrapyrroles as natural product structures. The functional roles of tetrapyrroles were a minor concern of this symposium; photosynthetically oriented investigators are represented by one paper on in vivo forms of chlorophyll, and electron transport is not discussed at all. Many of the papers go beyond the expected discussion of some high points of recent work by pointing out key unsolved problems in tetrapyrrole formation, some of which have evaded the probings of more than one laboratory for some years. The enzyme that incorporates magnesium into protoporphyrin remains undemonstrated; the mechanism of prophobilinogen condensation has not yet been verified; knowledge of the formation of the carbocyclic ring in chlorophylls is sketchy; some organic structural features remain in doubt in the chlorophylls (chlorophyll c and *Chlorobium* chlorophyll 660); and so on.

The emphasis in current work on tetrapyrrole biosynthesis has turned, as it has in other areas of biochemistry, from structures and pathways to mechanisms and regulation. Workers at the physiological end of the professional spectrum are wrestling with regulatory aspects of porphyrin biosynthesis expressed clinically in the form of porphyrias. The origins of these disorders lie both in genes and in chemical insults (for example, from lead or drugs) generally appearing as porphyrinurias (excretion of excess metabolites). It is intriguing that lead poisoning mimics acute intermittent porphyria, a genetic lesion. The porphyrinurias are probably only one expression of a more general disturbance of metabolism, and their study is particularly important in our pilled and polluted society.

JAMES H. MATHEWSON
Department of Chemistry,
San Diego State College,
San Diego, California

A Heteromorphic Process

Planarian Regeneration. H. V. BRØNDSTED. Pergamon, New York, 1969. viii + 280 pp. + plates. $13.50. International Series of Monographs in Pure and Applied Biology: Zoology, vol. 42.

Brøndsted's monograph draws together nearly 200 years (1774–1966) of literature on regeneration in planaria and will therefore be invaluable to all students of regeneration and development. Brøndsted senses the end of one long era of study in which the basic questions have been posed and the start of a new era in which these questions may be answered with modern tools and techniques. The scalpel will now yield to the ultracentrifuge and the electron microscope.

The regenerative processes were studied at one time or another by Darwin, Faraday, and Harvey, but it was not until T. H. Morgan and C. M. Child entered the scene that a firm basis for further fruitful investigation was established. Many questions posed by early investigators are largely unanswered, especially when considered in modern terms: Drapernauld (1800–01) writes that it can be asked of the psychologists in which half of a longitudinally