The Sea Floor

The Sea. Ideas and Observations on Progress in the Study of the Seas. Vol. 4, New Concepts of Sea Floor Evolution. ARTHUR E. MAXWELL, Ed. Wiley-Interscience, New York, 1971. Part 1, xiv, 792 pp., illus. $32.50. Parts 2 and 3, xiv, 664 pp., illus., + foldout maps. $32.50.

This volume of *The Sea* is in fact two volumes, part 1 being in one volume and parts 2 and 3 in another. It is dedicated to the memory of M. N. Hill, who was the general editor of the first three volumes. Since those volumes were published there has been what has been called a revolution in the earth sciences, namely the acceptance of the related concepts of sea floor spreading and plate tectonics by a large majority of earth scientists. This fourth volume is mainly about the sea floor and thus supersedes volume 3; the fields of study covered in volumes 1 and 2, physical oceanography, chemical oceanography, and descriptive and comparative oceanography, receive only 3 chapters out of the 36 in this volume.

I must confess to a certain amount of disappointment in looking at part 1, which is entitled General Observations. This consists of a series of discipline-oriented studies, dealing with, for example, various geophysical techniques or the different rock types found in the ocean basins. Most of the chapters were written some time ago, many bearing dates in 1968. In such a rapidly moving field many of the articles have become out of date, through no fault of the authors. I also found that some of the chapters in this part are very similar to articles previously published. The question is whether this series of chapters is convenient to have under one pair of covers. I suspect that it will be useful to scientists who are not specialists in the various subjects dealt with but want to get a general background in them.

The second part I found much more satisfying. It consists of a series of regional studies of the ocean floor and contains much excellent material. Many of the chapters in the second part combine different techniques that have been used and observations that have been made in the study of a particular area and attempt to arrive at a conclusion based on all the available data. The geology and geophysics of the areas discussed are given in a more complete manner than is usual, and this part hence proves a useful compendium of information. For instance, the chapter on the Mediterranean discusses bathymetry; gravity, magnetics, and heat flow; sediment cores and sea floor photography; seismic refraction, seismic reflection, surface wave dispersion and seismicity; and the geology of the surrounding land areas. It is a pity, as the editor points out in the introduction, that the coverage of the world's oceans is not complete. One deficiency is that there is no general discussion of the Atlantic Ocean, which is brought in only in articles devoted to the eastern margin of North America and the Caribbean.

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Atmospheric Puzzle

The Nature of Ball Lightning. STANLEY SINGER. Plenum, New York, 1971. x, 170 pp., illus. $12.50.

Here is the better of two recent books in English (the other is C. M. Cade and D. Davis's *The Taming of the Thunderbolts*, Abelard-Schuman) about a baffling atmospheric phenomenon which has so far defied duplication in the laboratory and for which there is no adequate theory. Ball lightnings typically are baseball-size, glowing, mobile spheres that appear during thunderstorms, usually after cloud-to-ground lightning. Singer presents a fascinating and detailed literature review (almost 600 references) of ball lightning research and observations. One of Singer's primary reasons for writing *The Nature of Ball Lightning* is that many modern investigators have ignored (or, to put it more charitably, have had no access to) valuable observations and theories from the past, particularly the 19th- and early-20th-century work by such scientific luminaries as Boyle, Arago, Snow Harris, Faraday, Planté, Lodge, Flammarion, Arrhenius, and Toepler. Many of the "new" theories, recently published, were first put forward in the 19th century.

While the descriptions of various ball lightning observations and the cataloguing of ball lightning characteristics are well done, the description of experiments and theories relating to ball lightning is a disappointment. The author states, "An attempt has been made to emphasize the physical meaning of the results. The mathematical expressions, although more concise, are usually omitted in the discussion, which should not prevent their regeneration by the reader when desired." What actually appears, however, is an abstract of each experimental and theoretical paper with little effort at explanation, identification of nonsense, or reconciliation of the conflicting views and numbers found in the different papers. Speculation is sometimes presented as if it were fact. The nonspecialist is bound to be confused. An inordinate amount of space, over 15 out of a total of 170 pages, is spent discussing the confinement and various properties of low-density, collisionless plasmas. Almost none of this discussion is applicable to the high-density, collision-dominated plasmas that occur in atmospheric air at lightning temperatures and below. The space could have been better spent in explanation of the more reasonable theories.

In chapter 3, "electric field" in units of volts is erroneously used in place of the proper "potential difference"; and "electric field gradient" in units of volts/meter is erroneously used in place of the proper "electric field" or "potential gradient." This type of error should not occur in a book about a phenomenon that may well be electrical. Singer states in chapter 3 that not all lightning flashes are preceded by leaders, a statement for which a reference would be of considerable interest.

The 594 references are arranged both in alphabetical order according to the author's name and by subject classification, a valuable asset.

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Space-Time Philosophy

The Conceptual Foundations of Contemporary Relativity Theory. JOHN COWPERTHWAITE GRAVES. M.I.T. Press, Cambridge, Mass., 1971. xii, 362 pp. $15.

Einstein's theory of general relativity, essentially unchanged since its conception in 1915, has often been hailed as one of the great revolutions of our basic ideas about nature. Since 1955 renewed interest has centered on the "geometrodynamical" interpretation, and unsuspected and fascinating features of this theory have emerged as more powerful mathematical methods have been applied to it. Yet, the most fundamental concepts in geo-

metrodynamics, such as space and time, are familiar from everyday experience. This is surely one of the reasons why this theory has stimulated thought in circles far beyond the small group of active researchers. Lacking in the literature has been a book treating these recent developments in a manner suitable for this larger audience.

Graves's book considers general relativity from the point of view of the philosopher of science. In the first part of the book he criticizes and revises important past interpretations of the nature of reality and develops his own philosophical framework for the discussion of physical theories. He then turns to his main concern, the evolution of concepts of space and time which culminated in general relativity. He traces this development from the Greek philosophers to the modern ideas of the Princeton school. Nearly a third of the book is devoted to a discussion of the physics of general relativity.

Although the mathematics is kept at a minimum, this book is not a popularized textbook of geometrodynamics. It is, rather, a scholarly work which attempts some completeness in its description and criticism of the views and attitudes that various thinkers have held. Graves does not confine himself to the most recent or most popular versions of physical theories. Thus, many typical conceptual questions and difficulties that arise when one is first confronted with the ideas of general relativity are discussed in more detail than in many texts. This book gives a fair idea of the complexity of the subject, and does not use analogies or pictures for simplification. It is not easy reading, and for a complete understanding the reader should be familiar with differential geometry and with much of the philosophical literature. For a qualitative understanding of the main line of argument, however, the book is reasonably self-contained. In fact, the last third does not rely extensively on the earlier parts and could profitably be read separately as an introduction to the main ideas of geometrodynamics.

Graves is at his best where discussing the striking new ideas in general relativity and the objections and misconceptions they have generated. Here for the first time in a book accessible to philosophers and others is a description of some of the new developments since Einstein. A number of errors and awkward arguments do not detract significantly from the discussion. The book's weakest point is its abrupt ending and omission of some important issues. In particular, there is virtually no mention of recent work on the inevitability of gravitational collapse and singularities. It would be difficult to find a topic of more impact on philosophical ideas about space and time than these singularity theorems. Graves's survey of the literature seems to have stopped in 1965, and only Wheeler's foreword puts this issue in its proper perspective. Also on the philosophical front one would like to see the discussion carried to greater completion: after the detailed discussion of the physical facts of general relativity, their consequences for ontology are confined to a few pages in the epilogue.

In spite of these limitations this book is a valuable source of information. It goes further than anything written before in explaining general relativity to philosophers and philosophy of spacetime to physicists.

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Solid State Physics

Physics of Crystalline Dielectrics. I. S. ZHELUDEV. Translated from the Russian edition (Moscow, 1968) by Albin Tybulewicz. Vol. 1, Crystallography and Spontaneous Polarization. xxii pp. + pp. 1–336, illus., + index. Vol. 2, Electrical Properties. xx pp. + pp. 337–620, illus., + index. Plenum, New York, 1971. Each volume, $25; the set, $45.

The dust jackets of the English translation of Ivan Stepanovich Zheludev's book promise, "*Physics of Crystalline Dielectrics* is an invaluable source of current information for solid state physicists, electrical engineers, and materials scientists." Unfortunately, the dust jackets are incorrect—owing to delays in the publication of the Russian edition and the translation into English, this treatise is almost a decade out of date. Thus the work concentrates on crystallographic structure and the phenomenological description of dielectrics; there is no reference to the neutron- or light-scattering experiments of the late '60's or to lattice-dynamical theories appreciably more recent than W. Cochran's and P. W. Anderson's papers on soft modes. Furthermore, the overpriced two-volume English translation omits the final 10 percent of what was a single Russian volume.

For those readers who do not require the most current information, Zheludev's 1964 review will, however, provide an enjoyable survey of the physics of ferroelectric, antiferroelectric, and pyroelectric materials. Only the first chapter of volume 1 may be difficult for a first-year graduate student—its discussions of symmetry, crystallography, and group properties are marred by the use of Shubnikov notation, some typographical errors, and an occasionally imprecise translation of the Russian. To some extent, the difficulties a novice might encounter with the Russian Shubnikov notation are alleviated by a fold-out dictionary which gives the equivalent Schoenflies and international notations for point groups. Still, chapter 1 is best read with pencil in hand, and the many tables should be examined carefully.

The central portion of the first volume consists primarily of equationless descriptions of the structures of oxygen-octahedral, hydrogen-bonded, and hindered-rotation ferroelectrics and antiferroelectrics. These sections are presented in a catalog-like style, with many figures and graphs included.

The last two chapters of volume 1 (on the pyroelectric effect and the theory of spontaneous polarization) are more quantitative than the rest of the volume, and might have been more at home in the second volume, along with material on relaxation, conduction, and piezoelectricity. All of these more quantitative chapters imitate the down-to-earth style of Charles Kittel's *Introduction to Solid State Physics*, while presuming only a knowledge of differential equations and some matrix algebra.

The overall impression the book leaves is that it is an encyclopedia of dielectrics which emphasizes facts more than understanding but illustrates the facts with many well-chosen figures, graphs, and tables. Like an encyclopedia, *Physics of Crystalline Dielectrics* is quite useful even though the information in it is not current; libraries that serve solid state laboratories should definitely obtain copies of it. Those researchers who expect to refer to it often, and who can afford the price, may wish to purchase both volumes; readers with a more casual interest in dielectrics will enjoy reading a library copy.

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