Book Reviews

Relativity and Other Subjects

Magic without Magic. John Archibald Wheeler: A Collection of Essays in Honor of his Sixtieth Birthday. JOHN R. KLAUDER, Ed. Freeman, San Francisco, 1972. xiv, 492 pp., illus. $19.50.

In these days of highly specialized science, a festschrift that accurately reflects the research interests of the festschriftee risks having its appeal restricted to a very narrow audience. Fortunately, the problem does not arise for this collection of essays in honor of John Wheeler, for Wheeler is one of the most versatile physicists of our times. Younger physicists, who know Wheeler chiefly through his work on general relativity and relativistic astrophysics, should look over the table of contents of this book and reflect that every one of the topics covered—nuclear fission, muonic atoms, *S*-matrix theory, quantum electrodynamics, and gravitational collapse, among others—received an important boost early on from a seminal paper by Wheeler.

As is appropriate in a festschrift, many of the articles here evidently represent fragmentary ideas with which the authors are still toying, and are more tantalizing than illuminating. Some are more substantial, however. The series of papers by Richard Feynman and Bryce DeWitt on the quantization of gravitation is worth the price of the book to field theorists. For many years, the main line of attack on this problem was through the canonical formalism, in which it is easy to keep track of the independent degrees of freedom of the gravitational field but very hard to maintain Lorentz invariance. In the early '60's Feynman opened up a new approach, in which Lorentz invariance is maintained at every step but fictitious degrees of freedom have to be introduced, through what are called "ghost loops." This work of Feynman's later flowered into a complete formalism for the quantum theory of gravitation through the work of Fadeev, Popov, Mandelstam, and DeWitt, and this formalism has recently played a crucial role in van't Hooft's proof of the renormalizability of unified gauge theories of the weak and electromagnetic interactions. However, until the publication of this book, Feynman's original ideas were available only in the transcript of a taped lecture given at Warsaw in 1963. (Talk about fast information retrieval!)

In recent years, Wheeler's interest has particularly focused on the problem of finding astrophysical phenomena in which the gravitational fields are strong enough to bring general relativity into play in all its nonlinear non-Euclidean complexity. There is nothing in this book about geons, but Kip Thorne's article does a good job of summarizing the work of general relativists on black holes. These are stars, of about a solar mass or more, whose temperature has dropped too low to provide enough pressure to balance gravitation and which enter on an unstoppable gravitational collapse. I found myself a bit dissatisfied with Thorne's survey of opinion on the existence of black holes. He lists the "establishment" view, that gravitational collapse really does occur more or less as described in the 1930's by Oppenheimer and Snyder, and the "radical" view that something even weirder may happen, such as a reemergence of the imploding matter somewhere else in space-time. I would also have listed a "reactionary" view, that massive stars simply explode when they grow too cold for gravitational stability, so that the formation of a "trapped surface" (after which the star must abandon all hope of avoiding collapse) never occurs. I do not say that the reactionary view is right, but the possibility ought to be kept in mind.

Apart from the breadth of his brilliant contributions to physics, there is another feature of John Wheeler that makes it easy to compile a festschrift for him—it is simply that he is one of the best-liked physicists around. I found the reminiscences in this book wonderfully evocative of Wheeler's personality, especially those of Edwin Taylor in the last article. For my own part, I can add that although I have disagreed with Wheeler many times in the 17 years I've known him, over issues ranging from geometrodynamics to civil defense, I have found it quite impossible not to be on good terms with him. Those who know John Wheeler will understand what I mean.

STEVEN WEINBERG
Department of Physics and
Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge

Seashore Patterns

Life between Tidemarks on Rocky Shores. T. A. STEPHENSON and ANNE STEPHENSON. Freeman, San Francisco, 1972. xiv, 426 pp., illus. Cloth, $15; paper, $6.95.

Many of the world's great naturalists, including Aristotle, Pliny the Elder, Linnaeus, and Darwin, have enjoyed the seashore. Possibly none has enjoyed it more than T. A. and Anne Stephenson. Probably none has seen as much of the world's seashore as they did, and certainly none has seen it with their appreciation of form and structure. Science begins with a search for unifying patterns in nature. The search for a universal pattern of intertidal zonation took the Stephensons to many of the world's shores, where T. A. Stephenson's artistic eye perceived as a Platonic ideal a universal pattern of zonation, which is sometimes clouded by a haze of natural variation. His paintbrush, line sketches, and selected photographs deftly cut through this haze and present to the reader a clear impression of zonation on many different shores.

Readers will find themselves thoroughly convinced that all of the marine organisms which reside in the intertidal region are exposed to physiological stresses resulting from the absence of seawater during low tides. The fact that these organisms have different tolerances to these stresses results in different upper limits to the range of their vertical distribution. Physical and biological factors which affect these physiological stresses usually modify the potential distribution limits. Each of the regions visited by the Stephensons is described with numerous qualitative observations which delimit the upper and sometimes lower limits of the ver-

tical distribution patterns of selected organisms. The emergent distribution pattern presented in *Life between Tidemarks on Rocky Shores* is one of tripartite zonation including a supralittoral fringe which contains little more than lichens; a midlittoral zone consisting most importantly of sessile animals such as barnacles, mussels, anemones, and tubeworms; and, finally, an infralittoral fringe usually consisting of algae in temperate regions and ascidians or corals in warmer regions.

It is generally assumed that science proceeds from descriptions of patterns toward an understanding of the mechanisms producing the observed patterns. Ideally the analyses of these mechanisms are based on controlled experimentation, and the synthesis should be sufficiently general to relate to other, similar patterns in nature. The rocky intertidal community is unique among natural communities, as a strong, experimentally based, functional appreciation of its organization is emerging. Controlled experimentation is allowing rigorous definition of the trophic and competitive roles of many populations and of their effects on the growth and regulation of other populations in the community. Unfortunately the Stephensons were little interested in such functional questions, and *Life between Tidemarks on Rocky Shores* contributes little in this direction; it does, however, add valuable comparative observations which facilitate generalization from experimental studies of restricted areas. For example, experimental studies have shown that the asteroids, carnivorous gastropods, and larger barnacles and mussels are functionally important species in the temperate midlittoral zone, and it is satisfying though not new or unexpected to learn that structural parallels occur in many widely separated intertidal communities, suggesting consistency in the functional roles that have been described. Probably the most important long-term contribution of the book is that it will serve as a vehicle by which other functional relationships discovered in the future in restricted areas can be generalized to other similar habitats around the world.

The descriptive value of this book is limited, however, because the Stephensons did not quantify their observations. Since the book describes seashore visits made 25 to 45 years ago, quantification could have provided a basis for comparison with the current status of these shores and thus given insights into long-term population fluxes. In this respect the book fails. For example, the sea otter (*Enhydra lutris*), once considered extinct, has made a remarkable recovery along the central California seashore. Because sea otters decimate populations of mussels, abalones, and sea urchins, they exert a profound effect on the entire nearshore environment. Naturalists have watched the recovery of the otter population with pleasure, but have failed to document community changes, and no quantitative data exist describing the affected habitat before the recovery of the otter population. Because the Stephensons visited Pacific Grove in 1947, one might hope to find in their description a measure of the situation before the otter recovery. Unfortunately, the book describes the abalone as "common" and the sea urchins as "astonishingly abundant," "pavements of thousands of individuals," and occurring in "countless numbers." Not even these rudimentary levels of quantification were achieved when the Stephensons visited the coast of Nova Scotia, which is thought to be strongly affected by the current overexploitation of the lobster population, which by its predation on the urchins is thought to have kept the urchins from overexploiting the kelp previously. Exotic algae, *Codium fragile* in the Atlantic and *Sargassum muticum* in the Pacific, have invaded the coasts of the United States and reputedly displaced native populations; again it is not possible to evaluate preinvasion populations from the relevant chapters. Finally, efforts to evaluate large-scale changes from the photographs lead to frustration, as most of the photographs are not dated and in many cases were taken by other people, so that their dates cannot be deduced from the dates of the Stephensons' visit.

For these reasons the book has restricted scientific value, but still it can be recommended to naturalists interested in nearshore biology. It is carefully written and attractively produced; it makes pleasant reading and is abundantly and lucidly illustrated with clear sketches and appropriate photographs. Perhaps most important, the book is unique as a succinct description of the shores of so many continents, some of which, particularly parts of Africa and South America, are very poorly known. Certainly *Life between Tidemarks on Rocky Shores* succeeds in what must be a main goal of the authors, as any reader will acquire a strong appreciation of unifying distribution patterns in the rocky intertidal community. A reader interested in more detailed descriptions of well-known shores would enjoy *The Ecology of Rocky Shores* by Lewis for the British Isles, *Between Pacific Tides* by Ricketts, Calvin, and Hedgpeth and *Natural History of Marine Animals* by MacGinitie and MacGinitie for the Pacific coast of North America, and *The New Zealand Sea Shore* by Morton and Miller for New Zealand.

PAUL K. DAYTON
Scripps Institution of Oceanography, La Jolla, California

On the Evolution of Life

Exobiology. CYRIL PONNAMPERUMA, Ed., North-Holland, Amsterdam, and Elsevier, New York, 1972. xx, 484 pp., illus. $32. Frontiers of Biology, vol. 23.

The flood of books, symposia, and meetings on exobiology and the origin of life seems unending. Reviewing the latest offering is a little like reviewing the latest recording of *Figaro*—how does Oparin's performance compare with his dramatic introduction of the subject in 1924? and so on. Let me state from the outset that the overall level of production and performance in this collection of articles is excellent. The book would make a splendid introductory gift for the graduate student, and should also give a good deal of nostalgic pleasure to the professional.

The first and longest part of the book is concerned with the evolution of life on Earth. In his introduction, Oparin takes a characteristically comprehensive view of the subject. Then we get down to detail with William Schopf's lucid account of Precambrian paleobiology, that is, the study of very primitive fossil microorganisms. Sylvester-Bradley does a workmanlike job trying to impose some sort of order on the confusing observations relative to juvenile carbon. Gabel and Ponnamperuma are old hands at primordial organic chemistry. Perhaps this is why their effortless performance seems a little dated.

At this point there is a slight surprise. The article by Pullman on electronic factors in biochemistry is unusual in this context, and William Bonner introduces a scholarly chapter entitled "Origins of molecular chirality" instead of the more usual chapter on optical activity. Both of these chapters intro-