

succeeding chapters have summaries of its thermodynamic properties, most of the book is written as a series of review articles with virtually all figures and tables taken from journal articles. The book reflects Jacobs's unusually wide interests and range of understanding, which extend from the seismic, thermal regime and constitution of the Earth's inner and outer core to (in a particularly strong chapter) the origin and spatial and temporal characteristics of the Earth's magnetic field. The origin of the Earth with its core is treated extremely broadly in a long chapter that covers both the relation of the core's composition to different theories of the cooling of the solar nebula as well as the formation of planetesimals and their accretion into the terrestrial planets.

The breadth of the book's coverage is demonstrated by several pages devoted to geophysical tests (both morphologic and paleomagnetic) of the famous 1938 speculation by Paul Dirac that the gravitational constant might be decreasing with time, and that the Earth (as well as clusters of galaxies) might be expanding with time.

Although some sections of the book have references as recent as 1986, notably absent in the discussion of the accretion of the Earth and other terrestrial planets is any mention of the research in the area of large-body impacts on the young Earth conducted by A. G. W. Cameron and Willy Benz (Harvard) in 1986 or the theories of magma ocean production developed by Yutaka Abe and Takafumi Matsui (University of Tokyo) in 1985.

My major concern about the book is that Jacobs does not critically evaluate the large number of hypotheses he reviews; as a result, readers without previous knowledge may be confused. Summaries and conclusions for each chapter would have been a welcome addition. Nonetheless, I highly recommend the book as a definitive reference.

Paul Melchior's considerably shorter *The Physics of the Earth's Core* is sometimes terse, but it is in fact an adequately referenced outline of virtually all the physics you need to know to understand the thermal regime, hydrodynamics, geomagnetism and evolution of the Earth's core. It emphasizes the considerable range of physics associated with the flow and the vibrations of the solid and liquid portions of the Earth's core. The book summarizes the core motions that can be detected, and some that appear difficult to detect, via the study of the Earth's proper motion, its seismologi-

cal behavior and the myriad phenomena associated with the magnetic field and its variation.

The mathematics and physics in the introductory chapter are hard to follow, but the presentations of thermodynamic, hydrodynamic, and geomagnetic theory in the book's later sections are clear and well-outlined. These sections, though not generally tutorial, provide good summaries of the mathematical and physical basis of our understanding of the core. Melchior explains some topics, for example, the Brunt-Väisälä oscillation, exceptionally clearly. He discusses poorly understood phenomena and limitations of both theory and observations and states explicitly the problems to be solved. The book has many unique figures and tables such as a five-entry listing of physical models of mechanical core-mantle coupling that includes thorough references to a rich literature. Melchior's expert presentation of core properties includes values for the various dimensionless ratios of hydrodynamic and electromagnetic quantities for both the outer (liquid) and inner (solid) regions of the core. This short book is an excellent value and I highly recommend it.

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Inside Relativity

Delo E. Mook and
Thomas Vargish

Princeton U. P.,

Princeton, N. J., 1987. 306 pp.

\$30.00 hc ISBN 0-691-08472-6

Go to the source. The first strength of *Inside Relativity* by Delo E. Mook, professor of physics at Dartmouth College, and Thomas Vargish, professor of English at the University of Maryland, is that they have observed this dictum. Their laudable collaboration across two cultures hews closely to the opening pages of Einstein's great papers, drawing strength and legitimacy from Einstein's simple and powerful insights and beautiful prose.

But insights are simple and powerful only when they answer the right questions. Many intelligent laypeople (and some professionals) are not clear about what questions relativity answers. Providing this context is the second strength of the book. The title of the second section says it simply: "Models: The Products of Science." The authors take us quickly through a "heuristic history" of astronomical models as illustrations of the kinds of questions that science can (and cannot) confront. The elements of New-

tonian mechanics illustrate these models and prepare us for Einstein's first paper on relativity.

This presentation is for those who wish to work carefully through the subject, anticipating difficulties, hearing it in different ways, tucking in each loose thread, relating new ideas to those that go before. The style is methodical and pedantic, employing long sentences rather than the staccato statements of much popular science writing. The understated stick-figure illustrations are mostly adequate, though I wished for figure legends to restate and to reinforce the concepts being illustrated.

The author's procedure works beautifully for the kinematics of special relativity, that is, the description of motion in flat space-time. And it helps us to penetrate some distance into general relativity, as far as Einstein's principle of equivalence. Their method runs into a brick wall, however, when Einstein turns to tensors. We still await the popular breakthrough in how to present the general theory of relativity. As an unfortunate result, their treatment of cosmology is mostly hand waving.

A section on how very fast objects would appear to the eye is exciting and unusual for a popular book. And readers will appreciate the book's helpful glossary. Several appendices provide more formal treatments for the more ambitious.

The weakness of this book is the obverse of its strengths. Setting the context, beginning with the sources, and carefully elaborating the logical consequences does not inform us about modern developments. We hear little about $E = mc^2$ or its implications, from particle physics to politics. We hear nothing about the ferment in general relativity that has transformed that field during the past 25 years. Readers who finish the book will want to move on to the brilliant popular description of recent applications of general relativity by Clifford M. Will in *Was Einstein Right?* (Basic Books, New York, 1986; reviewed in *PHYSICS TODAY*, May 1987, page 93).

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Fractals

Jens Feder

Plenum, New York, 1988.

283 pp. \$49.50 hc

ISBN 0-306-42851-2

How long is the coast of Norway? Actually, the question has no unique answer. Jens Feder shows in *Fractals* that the length depends on the resolu-

tion of the yardstick, increasing with a power $D = 1.52$ as the mesh becomes finer and finer. The coast of Norway is a fractal, and D is its fractal dimension.

Benoit Mandelbrot (IBM Thomas J. Watson Research Center), the inventor of the word "fractal," has pointed out in several books and articles that nature is full of such self-similar objects with noninteger dimension. Feder is a physicist at the University of Oslo, and his own research, carried out in collaboration with Torstein Jøssang, has been mostly on aggregation of protein clusters and on flow in fractured media.

Feder's book reviews experiments and observations of fractals in fields ranging from astrophysics and fluid dynamics to random walks and aggregation. The string-like arrangement of clusters of galaxies in the universe has a fractal dimension slightly larger than unity. In a chapter on "viscous fingering" Feder shows amazing patterns obtained from very simple experiments, such as the displacement of epoxy by air in a medium consisting of a monolayer of glass spheres between two glass plates. The experimental results can, to some extent, be described mathematically in terms of "inversion percolation," also reviewed in the book.

The fractals in Feder's book are seen through a physicist's rather than a mathematician's eyes. The focus is clearly on explicit descriptions of specific fractal structures in nature rather than on general mathematical statements and analysis or on numerical simulations and computer graphics of abstract mathematical fractals. In this way the emphasis clearly differs from that of Mandelbrot's books *Fractals: Form, Chance, and Dimension* (Freeman, San Francisco, 1977) and *The Fractal Structure of Nature* (Freeman, San Francisco, 1982) and Heinz-Otto Peitgen and Peter Richter's *The Beauty of Fractals* (Springer-Verlag, New York, 1986). All the examples are documented with raw, unmanipulated data so that readers can see for themselves precisely how the fractal analysis works. Feder's book is easy to read, but nonetheless it includes the most recent research in the field. For instance, the book reviews in great detail the multifractal analysis of convection in Rayleigh-Bénard experiments carried out by Mogens Jensen, Leo Kadanoff, Albert Libchaber and Itamar Procaccia, all at the University of Chicago.

I found the chapter on fractal records in time particularly interesting. It is an empirical fact that many

physical observables fluctuate much more in time than one would expect from the simple square root time dependence expected for stochastic processes. These fluctuations are characterized by the "Hurst exponent," which is usually greater than $1/2$. Following the general philosophy of the book, this rather complicated phenomenon is illustrated by a specific analysis of the history of wave height at "Tromsøflaket" at the Norwegian coast, using original data measured by the Norwegian Institute of Technology.

Despite the ubiquitousness of fractals, their origin is not at all understood. There is almost no theory of the dynamical processes leading to their formation. It seems strange to me that Feder, a physicist, never stops for a second to wonder *why* fractals appear everywhere. The origin of fractals is one of the great mysteries of physics and promises to be an exciting research area for the future.

The strategy of teaching through examples works extremely well. This is an excellent textbook for a physics course on fractals, guiding the reader to even the most up-to-date research on fractals while avoiding complex mathematical details. The abundance of fractals assures that the field is here to stay, and I recommend the book to anyone wishing to learn what they are all about. It is the best book I know of on fractals in physics.

PER BAK

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Harmony and Unity: The Life of Niels Bohr

Niels Blaedel

Science Tech, Madison, Wis.,
1988 [1985]. 323 pp.

\$35.00 hc ISBN 0-910239-14-2

The author of this biography, which was written for the centenary of Bohr's birth, is a Danish science writer. The book is intended primarily for nonphysicists; nevertheless it offers extensive (albeit nontechnical) accounts of all aspects of Bohr's scientific work. The consistent emphasis, however, is on Bohr as a person—his character, interests and *Weltanschauung*. Niels Blaedel was able to draw on matchless resources, both human and material: Bohr's family (especially his widow, Margrethe Bohr, who shared both her memories and her correspondence), Bohr's former friends and colleagues, and a rich supply of documentary and photographic material from Danish collec-

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