An Introduction to Chaotic Dynamical Systems

Robert L. Devaney
320 pp. Benjamin–Cummings, Menlo Park, Calif., 1986.
ISBN 0-8053-1601-9. $29.95

The field of chaotic dynamical systems has had such a success, and such extensive coverage in PHYSICS TODAY, that it suffices to recall here its main features: Even very simple deterministic systems in the laboratory or in mathematics exhibit apparently unpredictable dynamics, rich fractal structures that cannot be analyzed by such traditional tools of physics as Fourier analysis and mode expansions.

This generated much skepticism and, later, much enthusiasm in the physics community, and, to a lesser extent, in the mathematics community—as indicated, for example, by the large and still growing number of books on the subject.

Robert L. Devaney's book has a clear aim: To describe in a mathematically correct fashion some major aspects of discrete (in time) dynamical systems, that is iterated maps. Except for the last chapter only rudimentary knowledge of mathematics is expected from the reader. Devaney has made a great effort to provide a careful exposition, omitting no definitions. It is my belief that a reader who wants to learn the mathematics of the subject cannot really avoid an apprenticeship: This book provides an excellent occasion to learn the definitions and the facts.

The book does not address any physics, nor does it treat the important subject of dynamical systems continuous in time and of the ergodic theory of dynamical systems. I regret this, and I hope Devaney will write another book, in the same style, dealing with these matters.

The references are held to a minimum on purpose. I do not believe that this is helpful for the student who seeks familiarity with the subject. But otherwise I can recommend the book warmly—even to physicists.

Now a comparison with other books. On the mathematical side, we have *Nonlinear Oscillation, Dynamical Systems, and Bifurcations of Vector Fields* by J. Guckenheimer and P. Holmes (Springer-Verlag, New York, 1983)—somewhat wider in scope and on average easier reading than Devaney's book; *Introduction to Ergodic Theory* by Y. G. Sinai (Princeton U. P., Princeton, N. J., 1978)—which provides only an exposition of ergodic theory for dynamical systems. On the physical side, we have *L'Ordre dans le Chaos* by P. Bergé, Y. Pomeau and D. Vidal (Hermann, Paris, 1984)—a very nice, elementary exposition for physicists [see review in PHYSICS TODAY, January 1986, page 85; it has now been translated by L. Tuckermann as *Order Within Chaos: Towards a Deterministic Approach to Turbulence* (Wiley, New York, 1986)]; and *Deterministic Chaos* by H. G. Schuster (VCH Publishers, New York, 1984)—an exposition in easy style, but somewhat more sloppy. *Advanced Synergetics: Instability Hierarchies of Self-Organizing Systems and Devices* by Hermann Haken (Springer-Verlag, New York, 1983) is broader in scope, but less systematic than the other books. Of course, there are several other books, but my omissions do not reflect personal taste.

Finally, I coauthored a book—*Iterated Maps of the Interval as Dynamical Systems* by P. Collet and J.-P. Eckmann (Birkhäuser, Boston, 1980)—as well as two logically related reviews *Rev. Mod. Phys.* **53**, 843 (1981) and with D. Ruelle *Rev. Mod. Phys.* **57**, 817 (1985).

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Manhattan: The Army and the Atomic Bomb

Vincent C. Jones
660 pp. Center of Military History, United States Army (dist. by Supt. of Documents, Gov't Printing Office), Washington, D. C., 1985. $21.00

The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942–1946

Barton C. Hacker
246 pp. U. of Calif. P., Berkeley, 1987.
ISBN 0-520-05852-6. $25.00

Anyone who is familiar with the vast popular and scholarly literature on the building of the first atomic bombs during World War II might wonder what possibly could be left to say about the Manhattan Project. Vincent C. Jones's *Manhattan* and Barton C. Hacker's *The Dragon's Tail* show that quite a lot has remained obscure; both books provide new information and fresh perspectives that enhance our knowledge of the bomb project during and immediately after the war.

As the subtitle of his book indicates, Jones, a historian with the US Army's Center of Military History, focuses on the role of the army in running the Manhattan Project. His protagonist is General Leslie R. Groves, the intense, hard-driving, ambitious officer responsible for solving a series of perplexing problems to make scientific theories about nuclear energy into the realities of atomic bombs. In his discussion of the efforts to separate U^{235} from U^{238}, to produce usable quantities of plutonium, and to design workable bombs, Jones covers much of the same ground as Richard G. Hewlett's and Oscar E. Anderson Jr's monumental *The New World, 1939–1946* (1962). But he adds significant new information on the army's execution of key administrative functions, such as securing materials, acquiring land, generating electric power, and constructing communities to house thousands of workers.

Jones faithfully recounts the controversial aspects of the army's performance, some of which enraged Manhattan Project scientists and provoked allegations of having slowed progress on the bomb. This was particularly true of the policies of compartmentalizing scientific information and enforcing strict security measures (ironically, though, not strict enough to expose Soviet spy Klaus Fuchs). He concludes that "the Army was the organization best suited, and perhaps the only one able, to undertake the responsibility for administering a program of the magnitude and difficulty of the Manhattan Project." *Manhattan* is too long and detailed to appeal to a casual reader, but anyone seeking a handy and reliable reference will find it invaluable.

Hacker examines a subject that has been at best slighted and at worst neglected in other studies of the Manhattan Project. He describes how project scientists guarded against ever-present but poorly understood radiation hazards while racing to produce the bomb. After surveying prewar radiation protection efforts and the development of the first "tolerance doses," he discusses the work of the health physicists of the Manhattan Project. He shows how they expanded knowledge of radiation hazards and improved instruments to measure them. Hacker, a historian at Oregon State University who wrote this book as part of a contract with the Department of Energy, demonstrates that radiation safety was an important concern of top-level officials in conducting the first atomic bomb test in 1945 and the Bikini test shots in 1946. But he also emphasizes that radiation protection of participants or the public was not their primary consideration. Health physicists knew, he writes, that "radiation safety was only one [concern], and not the most important. It might well suffer in conflict with other test goals."

Hacker delivers an excellent analysis of the early history of radiation safety. He provides a clear exposition of a complex topic that needed careful scholarly treatment. His book is un-

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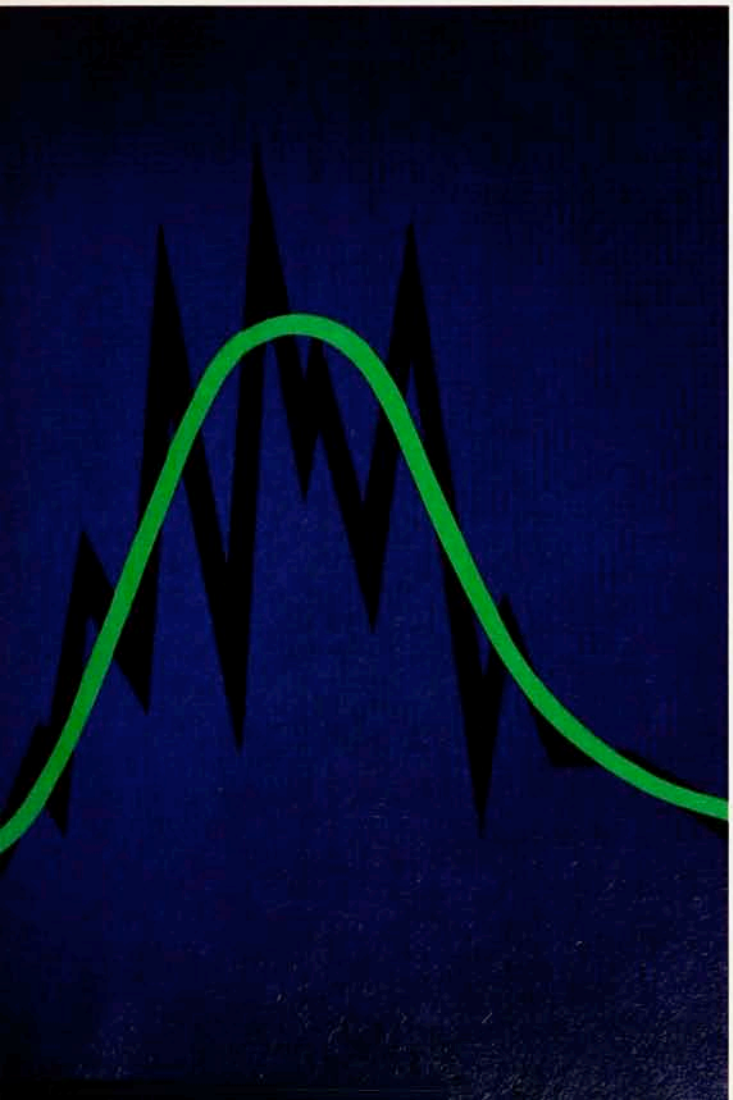

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likely to draw a popular audience, but those interested in the evolution of the theories and practices of radiation protection will find it interesting.

J. SAMUEL WALKER
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The Young Einstein: The Advent of Relativity

Lewis Pyenson
255 pp. Adam Hilger, Bristol, UK (US dist. Taylor and Francis, Philadelphia), 1985.
ISBN 0-85274-779-9. $44.00

Rumor has it that the about-to-be-published first volume of the Einstein papers, edited by John Stachel (see PHYSICS TODAY, May, page 45), contains a trove of newly discovered Einstein letters that will give us new insights into precisely the Einstein of the relativity years. Does this make the sort of close work done by Lewis Pyenson in *The Young Einstein*, presumably without the benefit of these letters, "academic?" I don't think so. What scholars like Pyenson give us is a context and a loving attention to detail. While I do not have the patience—or perhaps because I do not have the patience—for this kind of careful scholarship, I enjoy and admire it greatly. To me there is something fascinating about seeing the actual final examination Einstein took in 1896 when he left the cantonal school at Aarau for the Polytechnic Institute in Zurich. He was, for example, asked (Pyenson informs us) to consider a circle inscribed in a triangle with the line segments connecting the median to each of the apices in ratio of 1:2:3, and asked to find the radius of the circle. He got essentially perfect grades on both this and his physics examination, although, as is well known, his grades were only mediocre, compared with those of some friends among his classmates, once he got to the Polytechnic. I learned, incidentally, from the book, that Einstein actually took nine mathematics courses from Hermann Minkowski while he was there—none of which he seemed to have liked.

About half of the essays in the book deal with Einstein, or his family, directly. One wonderful essay, for example, has to do with the kind of electrical equipment manufactured by Einstein's father and uncle, and an analysis of why their businesses continually failed. It certainly was not for lack of ingenuity. With a little luck and more capital they might have become rivals to Siemens. The rest of the essays deal with the more general scientific and political environment in which Einstein found himself. They can be read, surely by readers of PHYSICS TODAY, although they are as technical as they need be. I would write more about them, except that I want to devote the rest of the few words of this review to a footnote—footnote 18 in the first essay: "Einstein's education: mathematics and the laws of nature."

Einstein was given some books—mathematics books—by his uncle Jakob and these, after Einstein's death, were given to his long-time secretary Helen Dukas. Pyenson writes in the footnote: "Miss Dukas declined to let me examine the books, which until her recent death were located at the Institute for Advanced Study, Princeton." I do not know what lies behind this footnote, but I do know a good deal about the arbitrary and capricious attitude of the trustees of the Einstein estate—especially that of the late Otto Nathan—towards scholars who needed access to the material. I had the misfortune of trying to get permission, for nearly a year, to use quotations from *published* material owned by the estate. Otto Nathan attempted to exercise control over the profile I wrote of Einstein for the *New Yorker*. It was a nightmare. I can still hear his voice telling me that I was always free to paraphrase. I think there are some valuable lessons to be learned from what happened to the Einstein estate; I hope that that is a story that some scholar will soon tell.

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My Daughter Beatrice: A Personal Memoir of Dr. Beatrice Tinsley, Astronomer

Edward Hill
xx + 118 pp. American Physical Society, New York, 1986.
ISBN 0-88318-493-1. $11.00

This biography of a brilliant theoretical astrophysicist, written by her father largely on the basis of hundreds of letters, can be read on several different levels. At first sight it is the appreciative and touching story of a gifted child, her education, her personal life, the evolution of her career, and the fortitude with which she coped with cancer during her last three years.

Beatrice Hill was born in England in 1941 and grew up in New Zealand, where her father was an Anglican clergyman. She was a brilliant student, excelling in mathematics but also becoming an accomplished amateur violinist. After college she married a young physicist, Brian Tinsley, and came with him to Dallas in 1963 when he obtained a position at the Center for Advanced Studies there. But Dallas offered little scientific opportunity for Beatrice, and in 1964 she enrolled in astronomy at the University of Texas at Austin, where she took her PhD late in 1967, having commuted from Dallas for half of each week. Her thesis opened up the study of galactic evolution and its relation to cosmology. Nontechnical references to her scientific work were part of her letters home, but this volume also includes an extended introduction and an obituary that summarizes her main research contributions. Most of her papers were published in specialized professional journals. Her 1977 article in PHYSICS TODAY (June, page 32), "The cosmological constant and cosmological change," which appears in the *Astrophysics Today* (AIP, New York, 1984) reprint book, will give the non-specialist an idea of some of her research. She published close to a hundred papers, but she also liked to teach and was in demand as a speaker at scientific meetings. Her last paper was written from her hospital bed, where she died in 1981, at the age of forty.

Beatrice Tinsley left an important intellectual legacy, and is vividly remembered as a stimulating and generous colleague. She was clearly a delightful person. On social issues, such as the Vietnam War and planned parenthood, Beatrice was not bound by convention. But society, or her perception of her role in it, was responsible for genuine unhappiness in one area. She had decided on her career goal toward the end of her first year in college, but in the same letter home she wrote "because I am a woman, my home must come before my science." Home and family were very important: When she was unable to bear children herself she adopted two in succession. The five year period following her PhD was devoted largely to domesticity, but she kept some professional work going and her scientific reputation grew. She began to be invited for extended visits to various institutions—in Pasadena, Santa Cruz, Maryland, Cambridge (UK)—taking the children when she could make proper arrangements for them, and getting back to Dallas when she could. Her husband was away even more. She designed the Astronomy Department when the Dallas Center became a branch of the University of Texas, but never obtained a faculty position there. Good offers did come from other places, the most congenial from Yale. Going there as associate professor in 1975 involved leaving home and children, a decision that was a source of sorrow and remorse, even guilt. Her scientific career, to which she was driven by her genius and enthusiasm, was incompatible with the