FINDING SELF-SIMILARITY IN A WORLD OF COMPLEX SYSTEMS

Fractals, Chaos, Power Laws: Minutes from an Infinite Paradise

Manfred Schroeder
Freeman, New York, 1991.
429 pp. $32.95 hc
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Reviewed by Kurt Wiesenfeld

There is a trend among physicists when confronted with a complex phenomenon to describe it as a self-consistent whole, rather than a collection of neatly independent—and ultimately simple—pieces. While there is no consensus on the best way to quantify complexity in general, we think of fractals as representative of spatial complexity and chaos as the hallmark of temporal complexity. Scientists have pursued these subjects diligently in recent years, and the ideas that have emerged carry a great deal of allure and power. The subject has also generated more than its share of buzzwords and a library's worth of coffee-table picture books.

In the preface to his latest book, Manfred Schroeder writes that "the unifying concept underlying fractals, chaos and power laws is self-similarity." Complex systems then are not random aggregates but have an internal order in which pieces of the systems are, roughly speaking, miniature copies of the whole. Schroeder draws together an impressively diverse set of examples to show us that nature is absolutely full of self-similarity. The book will not convince the skeptical reader of the inevitability of this world view. The willing reader, however, can sit back and enjoy an all-encompassing, irrepressibly enthusiastic tour, ranging from psychophysics to quasicrystals, from gambling strategies to Bach concertos, from the construction of Cantor sets to the design of concert halls.

The book is appropriate for the scientifically inclined, an audience comfortable with reading *Scientific American*. Schroeder, a physicist who holds over 40 patents and is also the author of a book on number theory, touches on a great many topics, and the book tends to jump around rather than follow a steady progression. Happily, there is a good deal of cross-referencing, which is useful for the reader who can't resist turning instantly to the sections on beating roulette or the Cantor-set sundial.

The teacher looking to spice up an undergraduate course with an occasional lecture on frontier topics can find suitable overviews of percolation, cellular automata, real-space renormalization and chaos in the logistic map. The book is also a nice source of quotable quotes (for example Pauli's "If a theoretician says 'universal' it just means pure nonsense") and beautifully popular examples, like the mode locking between a frustrated pedestrian and city traffic signals. Also thrown in are bizarre historical footnotes, including descriptions of a devious and deadly cavalry maneuver used by Genghis Khan, the astonishingly public birth of the Holy Roman Emperor Frederick II and Leibniz's invention of the binary number system while waiting to see the Pope.

As notable as the book's broad sweep is the author's good-natured, humorous presentation. The style is casual rather than technical, playful rather than pedantic. Schroeder has an obvious love of language, which he displays by way of amusing anecdotes, occasional alliteration and (lookout!) numerous puns. He also tends to go overboard in connecting as many "big ideas" as possible, so that some allusions—to, for example, global warming, dinosaur extinction, cosmic strings, dark matter and superconductivity—come across as gratuitous. This may annoy some "serious-minded" readers, but for others it will probably help to convey the high level of excitement associated with the scientific frontier.

Because the depth of treatment is highly variable, the book has something for everyone. For example, the precocious undergraduate who devours James Gleick's popularization *Chaos: The Making of a New Science* (Viking Penguin, New York, 1987) and craves a more meaty follow-up should tackle Schroeder's book cover to cover. The scientist who is somewhat familiar with the standard examples of fractals and chaos can dip into the book here and there. And even the expert is bound to come across several unfamiliar examples. In all cases, extensive references to the technical literature enable motivated readers to pursue those subjects that particularly excite their imagination.

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Nuclear Structure from a Simple Perspective

Richard F. Casten
Oxford U. P., New York, 1990.
376 pp. $59.00 hc
ISBN 0-19-504599-5

The topic of this book, nuclear structure, is currently enjoying something of a revival. This renaissance is due mainly to the discovery in 1986 of super-deformed nuclei. Although the developments in this area have occurred too recently to be included in this book, they provide an excellent reference for many of the underlying concepts in nuclear structure theory.

One hopes that nuclear structure physics will attract more interest in the 1990s than it did in the 1980s, and Richard Casten's book provides a beautiful and very physical presentation of some of the essential material. Casten is a senior nuclear physicist at Brookhaven National Laboratory. His group has probably done more than any other in studying the experi-