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Book review

'Fractals, chaos, power laws: Minutes from an infinite paradise'

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Manfred Schroeder, *Fractals, chaos, power laws: Minutes from an infinite paradise* (W.H. Freeman, New York, NY, 1991) $32.95, 429 pp.

Fractals refers to fractal geometry, a new branch of mathematics currently in turmoil. Several lawsuits are pending against Benoit Mandelbrot, its founder, and bile blackens the pages of the gossip columns of the mathematical community.

Chaos refers to dynamical systems theory, a three-hundred-year-old branch of mathematics which also knew controversy in its infancy. The computer revolution has turned dynamical systems theory on its head, causing new controversy, and spawning a new name, chaos theory, for dynamics. The fact that chaos theory is about chaotic attractors, which are also fractals, has inclined some people to mistakenly identify chaos theory with fractal geometry.

Power laws refers to a relationship between two variables, in which one is proportional to a power of the other. It characterizes fractals, and many other objects found in nature.

This book is primarily about physical applications of fractal geometry. It complements the standard texts on fractals, which generally tend to an abstract mathematical formalism, overlooking the ubiquity of fractals in Nature. Of these texts, the best known are the following:

Mandelbrot (1977). Mandelbrot invented fractal geometry, and presented it first in his *Les objects fractals: Forme, hasard et dimension* in 1975. The English translation and second edition, appearing in 1977, is much modified and augmented, according to the author's foreword. Besides an introduction to the subject giving much credit to historical mathematicians, it treats extensively the coast of Britain, the Missouri River, Brownian motion, noise, galactic clusters, turbulence, moon craters, crystals, word frequencies, and many other examples. It contains 64 illustrations.

Mandelbrot (1982). This is the third edition of Mandelbrot's classic work. It presents many additional applications and illustrations, including a 'book within a book' of color plates. The second printing of 1983 includes another dozen or so applications and an augmented bibliography.

Peitgen and Richter (1986). A best-seller because of its clear presentation and superb color graphics, this work is devoted primarily to a branch of fractal geometry which overlaps chaos theory: iterated functions. The Julia and Mandelbrot sets are extensively explored.

Peitgen, Saupe, and Richter (1988). Companian volume to the preceding, with a clear exposition of the mathematical theory behind the pictures.

Peitgen, Saupe, and Juergens (1991). First of two volumes devoted to fractals, chaos, and dynamics. It begins with a foreword by Benoit Mandelbrot, which is an important contribution to the ongoing controversy about fractal geometry. The chapters are: iteration, classical fractals, self-similarity, dimension, image encoding, the chaos game, and landscapes. The second volume will deal with: growth, cellular automata, mixing, period doubling, Julia sets, and the Mandelbrot set. This is a massive synthesis of the new subject, with 289 illustrations in the first volume alone.

Barnsley (1988). A very friendly introduction, with emphasis on iterated function systems. There is a software package which illustrates the book.

Falconer (1990). This is a rigorous math text on the theory of dimension.

Edgar (1990). Another rigorous math text.

Kaye (1989). A wonderful book full of interesting applications.

The serious student of fractals and chaos must obtain experience in a computer graphic lab. The following are very helpful in this regard:

Rucker (1991). This program for IBM PC clones is very reliable and simple to run, providing a laboratory to explore all the classical fractals. Comes with an excellent manual.

Wahl (1985). A chaos and fractal lab for the Macintosh, very simple and easy to run.

Garcia (1991). An easy-to-read introduction to fractals, and manual for Wahl's program.

We may say that most generally, fractals display two special features: fractal dimension and self-similarity. These special features are treated in all of the texts described. With this in mind, we now turn to Schroeder's book. Its main theme is one of these special features: self-similarity. Within 400 pages and 17 chapters over 150 detailed scientific applications of fractal geometry to exemplary natural systems are found. Each is presented rigorously and with an adequate bibliography. The book is thus the most extensive collection available today, and represents an astounding accomplishment by the author, an acoustician, physicist, computer graphic artist, and author of *Number Theory in Science and Communication.*

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