

## **Book Review: *Chaotic Dynamics—An Introduction***

**Chaotic Dynamics—An Introduction**, Gregory L. Baker and Jerry P. Gollub, Cambridge University Press, Cambridge, 1990.

These days everybody realizes the necessity of including the subject of chaos in the syllabus of a faculty of science. One can (comparatively) simply solve two limiting cases, either giving a hard graduate course for (theoretical) physicists or mathematicians, or give qualitative lectures suitable for freshmen or psychologists. In fact, all existing books or review articles on chaos are appropriate for one or the other of these two purposes. I know from my own experience that it is much harder to teach chaotic dynamics in a period, say, of 3 or 4 weeks as a natural part of a regular undergraduate course in analytical mechanics or differential equations.

Much work has been done by the authors of the book under review with the view toward extracting the key problems in dissipative chaotic dynamics and summarizing them very clearly in some hundred pages. More than one-third of the space is filled with illustrative figures and problems. The use of a single example, namely a driven damped oscillator, instead of the countless applications of chaos (which are, nevertheless, mentioned in the concluding remarks), is another successful pedagogical feature of the book. And, finally, the authors suppose that a student reading this book will hold in his or her hand a calculator, performing some numerical simulations to illustrate the theoretical points. Thereby, not only has a fresh spirit been infused in the 400-year-old pendulum problem described in many thousands of books, but the reading of the book becomes a creative work. A famous legend says that Mich Feigenbaum came to his well-known results playing with a pocket calculator. One may hope that boys and girls who use computers as toys in their perambulators will convert into "Feigenbaums" after reading this (and other) books.

The book consists of a Preface, six Chapters, and two Appendices. The introductory Chapter 1 describes the general features of chaos, and singles out the three control parameters in the equation of motion of a driven damped pendulum. Chapter 2 contains a brief description of the three main

mathematical constructs (phase space, Poincaré sections, and spectral analyses) which are applied to a pendulum in Chapter 3, which is deservedly called "Visualization of the pendulum dynamics." The discrete maps are used in Chapter 4 to explain the different features of a pendulum. The logistic maps are considered in more detail, while the standard map helps to understand the "phase locking" of a pendulum, and the horseshoe map is used to explain the behavior of a pendulum near the saddle points. Chapter 5 contains a description of fractals, which helps to explain the geometric properties of chaotic attractors. Special attention is paid to Lyapunov exponents and their connection with the Kolmogorov entropy and (capacity, correlation, and information) dimensions. The concluding Chapter 6 contains a short description of other applications of chaotic dynamics (fluid dynamics, chemical reactions, and lasers) as well as their relation to quantum physics and statistical mechanics. Chapters 2-5 are concluded by problems and simulations. Some computer programs needed to solve the problems, and the Runge-Kutta method of numerical integration of differential equations, are given in two Appendices.

I have some doubt whether Chapter 5 should be an integral part of an undergraduate course. Some general approach to the Hamiltonian (non-dissipative) dynamics should probably be given instead. On the other hand, the topics described in Chapter 2 might be taught in more detail in a more elementary course. There is no doubt, however, that Chapters 3 and 4 will be used by many students and teachers of science as a well-written introduction to dissipative chaotic dynamics. Cambridge University Press deserves to share the success of this book with the authors: the excellent typographic work makes the reading of this book not only useful, but also very pleasurable.

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