Journal of Statistical Physics, Vol. 57, Nos. 5/6, 1989

Book Review: *Chaos and Integrability in Nonlinear Dynamics*

Chaos and Integrability in Nonlinear Dynamics. Michael Tabor, Wiley, New York, 1988.

This book consist of three parts, of different degrees of complexity. The first three chapters contain the traditional Hamiltonian mechanics and differential equations slightly complemented by a geometric interpretation. The more or less traditional description of chaos in the Hamiltonian and dissipative systems forms the basis of the next two chapters. Finally, the last three chapters (semiclassical mechanics, solitons, and differential equations in the complex plane) are written on a more complicated level, especially the last chapter.

The author emphasizes in his introduction that the aim of his book is pedagogical, and that it can serve as the basis for a course in nonlinear mechanics and chaos. The book is, in fact, pedagogical: the author uses many handwaving and illustrative examples to explain complicated results. However, readers interested in finding, in a book on chaos, statements of new questions, provocative ideas which are able to help readers in their own research, original opinions, or a new look at old problems will be forced to turn to other texts and monographs.

The necessity of a special course in nonlinear mechanics is an example of the eternal problem of introducing "new" fields into classical courses, or even replacing one course by another one. It is always very hard and indeed painful to squeeze dozens or hundreds of years of scientific development into three or four years of undergraduate study. I remember the answer of the late E. Lifshitz to my question many years ago of why he did not include in a new edition of *Statistical Physics* by Landau and Lifshitz the scaling theory of phase transitions, which was widely used even at that time. The answer was that the scaling is not "canonical" enough to be included in a text. As a matter of fact, he included scaling in the next edition. It is worth mentioning that nonlinear dynamics, strange attractors, and chaos seem to be "canonical" enough to be included in new editions of *Hydrodynamics* (1988) and probably will be essential parts of the expected new edition of *Mechanics*.

0022-4715/89/1200-1137$06.00/0

It is too hard to introduce a special course on nonlinear dynamics and chaos into an already overloaded undergraduate study, but these subjects must be included nowadays as part of the undergraduate courses on analytical mechanics, hydrodynamics, and differential equations (for physicists). For this purpose, the following parts of the book under review seem to be of special importance:

1. All possible fixed points for the second-order differential equations, illustrated by the examples of the damped harmonic oscillator and the pendulum (pp. 20–31).
2. Action–angle variables, motion on the tori, and integrable systems (pp. 65–79).
3. Quite simple illustrations of the KAM theorem (pp. 105–111, 126–135).
4. Computer experiments on the chaotic Hamiltonian flow between two rotating eccentric cylinders (pp. 176–179).
5. The Lorentz model of strange attractors (pp. 204–212).

This list may be supplemented by a few simple yet elegant "chaotic" experiments described recently in the *American Journal of Physics*. These include a ball bouncing on a vibrating table [*Am. J. Phys.* **54**:939 (1986); **55**:316 (1987), **56**:1147 (1988)], a compass needle in an oscillating magnetic field [*Am. J. Phys.* **54**:800 (1986)], and nonlinear electronic circuits [*Am. J. Phys.* **53**:332 (1985)]. One can even discuss chaos versus predictability in the formation of a national strategic security policy [*Am. J. Phys.* **57**:217 (1989)]! Different applications of chaos in the natural, social, and medical sciences should be an integral part of undergraduate study.

Nonlinear dynamics and chaos are, of course, good topics for graduate courses. It does not seem, however, that this book could serve as a basis of such a course, primarily because of the choice of subjects in the last three chapters. Those are chosen probably more by the author's fields of interest than by the necessity to be included in a course of nonlinear dynamics and chaos.

The book is written in lively language, contains many useful remarks, and will be read with keen interest by scientists and students who have some experience in nonlinear dynamics.

Moshe Gitterman

Department of Physics
Bar-Ilan University
Ramat-Gan, Israel