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REVIEWS

Chaotic Dynamics: an Introduction. By G. L. Baker and J. P. Gollub. Cambridge University Press, 1990. 182 pp. £25 (hardback) or £9.95 (paperback).

This excellent book develops the foundations of chaotic dynamics from the viewpoint of a physicist at a level that is accessible to the undergraduate student. It is comparable in intellectual demand with F. C. Moon's *Chaotic Vibrations* (Wiley, 1987) but requires much less background than that graduate-level text. The authors manage to cover almost all of the basic concepts and tools of chaotic dynamics – logistic maps, phase spaces and trajectories therein, Poincaré sections, time series and power spectra, basins of attraction, bifurcations (rather lightly), period-doubling cascades, fractal dimensions, and Lyapunov exponents – by focusing on the periodically excited, damped pendulum as a canonical example. They do include, in their final chapter, applications to fluid dynamics, chemical reactions, lasers, quantum mechanics, and statistical mechanics, but these require more antecedent knowledge than the preceding chapters and presumably would require selection and expansion by the lecturer. They also include exercises for the student, an appendix on Runge–Kutta numerical integration of differential equations, and program listings (in True Basic language) for the exercises. The illustrations are frequent, simple and clear. A diskette for IBM-PC-compatible computers (a Macintosh version may now be available) with programs that can duplicate or vary the simulations discussed in the text is available from the authors for $12.

Baker & Gollub have, I believe, succeeded admirably in achieving their declared goal of making this important and fascinating subject accessible to undergraduates, and I have but minor complaints to offer. They allege that the only prerequisites for their text are linear differential equations, introductory physics (basic mechanics), and PC-level computing, but it appears to me that either the student requires some prior knowledge of phase-plane analysis and elementary bifurcation theory or the material in chapter two requires amplification and supplementation by the lecturer. The resonance curve (response versus drive) of the periodically driven pendulum, which I have usually found to be the most revealing of all plane portraits, is neither mentioned nor displayed. And, although it is difficult to overestimate the contributions of Poincaré to this subject, I believe that the authors' attributions (or absence thereof) may have succeeded in doing just that.

That *Chaotic Dynamics* is aimed primarily at undergraduates should not preclude its use at more advanced levels. The teacher of a graduate fluid-mechanics course who finds Guckenheimer & Holmes (*Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields*, Springer, 1983) too intimidating or Moon (*l.c.a.*) too wide-ranging might well look to Baker & Gollub for the fundamentals of chaotic dynamics and proceed from there to discuss its implications for such problems as turbulence. Or, perhaps with even greater profit, the fluid-mechanics specialist might consider the challenges and rewards of offering an undergraduate course on one of the most exciting developments in classical physics in this century.

John Miles

Theories of Fluid Flows Through Natural Rocks. By G. I. Barenblatt, V. M. Entov and V. M. Ryzhik. Kluwer Academic Publishers, 1990. 395 pp. £95 or $147.

This is an expanded and fully revised edition of the original Russian edition. Although the purist might wish to see a few grammatical and stylistic faults corrected, no reader will have any difficulty whatever in reading this text, and the authors are to be congratulated on mastering what to them is a foreign language.

Its contents are built around work done over a period of 30 years by the three authors and largely reported in the Soviet literature. In many cases they anticipated similar work done much later in the 'West', and in some their work is essentially unknown to the world at large. For this reason alone, it is extremely valuable to have it collected together in one volume. Most of the work refers to applications in the oil and gas production industry, though for good historical reasons some problems of groundwater flow are introduced (there is an exact parallel between certain gently sloping unconfined water flows and confined compressible gas flows).

The text stands well on its own and should be read and studied as a whole and not in parts. The further I got into the book, the better I appreciated it. It is not a compendium of isolated results obtained using different approaches, approximations and notations (as is sometimes the case with prolific authors), but a beautifully crafted and balanced work setting out in a rational, consistent and scholarly way both the continuum-mechanical models that have provided a successful description of testing and production flows in the oilfield, and a fairly complete set of basic analytic solutions to the main important initial and boundary-value problems that result from these models.

Those familiar with Barenblatt's other texts will expect to see powerful use made of dimensionless, asymptotic and self-similar techniques: they will not be disappointed. To an older generation such methods provide unique insight into the mechanics of the real processes involved, early recourse to computed solutions being no substitute for dimensional analysis, for perturbation and matching methods in deriving general results that can be used in analysing field problems. The level of detailed mathematics included is perfectly judged to make the book both readable and convincing. Those intending to carry out detailed investigations are given an excellent start, and younger workers may learn some new techniques.

There are six chapters, covering basic physical concepts, classical linear models of homogeneous fluid flow, classical nonlinear models of homogeneous fluid flow, non-classical flows (fractured porous or layered reservoirs, non-Newtonian homogeneous fluids, elasto-plastic porous media), two-phase flows and finally physico-chemical flows (those involved in enhanced oil recovery, involving heat or mass diffusion, and where relevant chemical reaction). Reservoir engineers will notice few if any important omissions, and should benefit not only from the references given to Russian papers but also from the informed selection made from the wider literature. They and chemical engineers will welcome the firm grasp displayed of practical aspects of the processes involved. Some will meet hodograph methods for the first time; others will be intrigued by the use of a Bingham model for certain crudes; most will enjoy the crisp treatment of fingering instabilities, flow in inhomogeneous media, end effects and lag effects in reaching capillary equilibrium.

J. R. A. Pearson