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Book Reviews

Chaos, Edited by Hao Bai-Lin. World Scientific Publishing Company Singapore, 1984.

Regular and Chaotic Motions in Dynamical Systems, Edited by G. Velo and A. S. Wightman. Plenum Press, New York, 1985.

Chaotic Behavior in Quantum Systems, Edited by Giulio Casati. Plenum Press, New York, 1985.

These three volumes attest to the vigor and diversity of chaos research. The Hao volume is an anthology of reprints on classical chaos, the Velo-Wightman collection is devoted primarily to rigorous mathematical developments in classical dynamics, and the Casati proceedings describe the ongoing search for chaos in quantum mechanics. These volumes form a chaos trilogy which provides a reasonably balanced view of contemporary nonlinear dynamics/chaos. This informative trilogy, however, occupies but a part of an already long and rapidly growing bookshelf describing this subject area, an interesting scientific "explosion" to which we later return.

The Hao anthology samples widely from this bookshelf but restricts itself primarily to dissipative chaos. In Part I of this work, Professor Hao presents a sequence of brief but informative introductory remarks as preparation for the chapters of reprinted papers which follow in Part II. Although a theorist may detect a few small errors of fact or interpretation in this introductory material, the freshness of experimental viewpoint more than makes up for any minor quibbles. The papers reproduced in this volume were selected with the greatest care and each contributes its share to the superb quality of the whole. Finding noted papers by Kolmogorov, Landau, Ruelle and Takens, Lorenz, May, Feigenbaum, Swinney and Gollub, and Pomeau and Manneville would easily justify the price of the volume, but there is actually much more as the reader will discover. Indeed, the very addition of this anthology to the expanding bookshelf on chaos certifies the publisher's faith in a growing market for chaos reviews.

How are we to account for this widespread current popularity of chaos in the scientific and lay press? Art Wightman suggests it is due to a handful

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of seminal papers; independent corroboration is found in Hao's anthology, which reprints most of the papers on Wightman's list. Moreover, the entire Velo–Wightman volume tacitly supports Wightman's thesis. Two excellent articles by Leo Kadanoff review and extend the seminal efforts of May, Feigenbaum, and Swinney-Gollub. Oscar Lanford presents a tutorial on the hyperbolic set of Anosov-Smale and the β-shadow theorem of Anosov–Bowen. Shelton Newhouse provides a modern setting for the homoclinic–heteroclinic points of Poincarè. Giovanni Gallavotti discusses KAM theory from a renormalization viewpoint. Pierre Collet and Jean-Pierre Eckmann review invariant measures for mappings of the unit interval. Finally, integrable system theory is reviewed by Eugene Trubowitz. In short, Professors Velo and Wightman have prepared a feast for the orthodox. A rigorously clear, slow and winding, evolutionary path of achievements is traced from Poincarè to the present. But does even this entire history explain the current popularity of chaos? Let us see if any enlightenment on this point can be found in the pages of Casati's collection on quantum chaos.

Here, as with the Velo–Wightman volume, we find articles reviewing and extending earlier work on significant topics: for example, Schrödinger's equation with random or almost periodic potentials; the character of eigenvalues and eigenfunctions for quantum systems which are classically integrable, near integrable, or chaotic; diffusion or its lack in time driven or spatially unbounded systems; and semiclassical studies, especially of chemical systems. However, this volume contains one strikingly new element not to be found in most collections on classical chaos. Its authors freely admit that chaos has not yet been adequately defined in quantum theory or, by implication, in classical dynamics as well and that this definitional issue matters, for there is presently no evidence of "chaos" in Schrödinger quantum mechanics beyond the level of mixing and/or ergodicity. Is it the notions of quantum mechanics or the notions of chaos theory which must change? And here at last, we find a meaningful clue regarding the popularity of chaos.

Chaos is popular because it addresses excitingly new and sometimes profound issues. Indeed, chaos has the attraction and power of an idea whose time has come, a huge and virgin mine of golden opportunities so numerous and so significant that fame and fortune appear to await us all. "There is a tide in the affairs of men which, taken at the flood . . . ," and the tide is on the rise. But it is not merely the work of isolated individuals or even of books such as these which swell this tide; it is much more the opportunity for meaningful dreams which fire the imagination that is crucial. And it is precisely such dreams that chaos provides. For, as sure as God made little green apples, chaos is dynamics freed at last from the shackles of order and predictability. It is systems liberated to randomly explore their

every dynamical possibility. It is exciting variety, richness of choice, a cornucopia of opportunity. For those who would harvest this richness, tools of the trade are to be found in the three volumes provided us by Professors Hao, Velo, Wightman, and Casati.

Joseph Ford
School of Physics
Georgia Institute of Technology
Atlanta, Georgia 30332