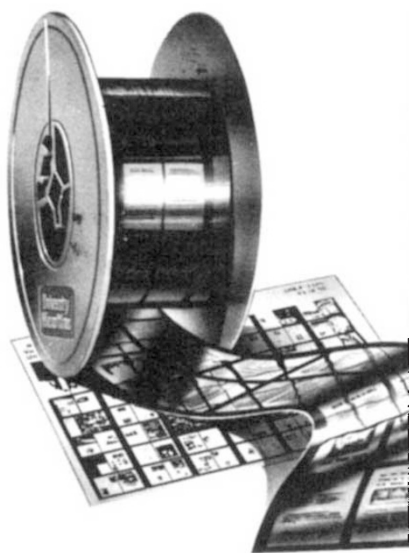


# nature

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## Uncertain gift

Brian Pippard

**Chaotic Dynamics. An Introduction.** By G. L. Baker and J. P. Gollub. Cambridge University Press: 1990. Pp 182. Hbk £25, \$49.50; pbk £9.95, \$17.95.

CHAOS must be counted among the gifts the computer has brought to science, for it is only after immensely long computations of the development of nonlinear dynamical systems that the pervasiveness and complexity of chaos have come to be recognized. It could be argued that its study is hardly a branch of science, as the most characteristic property of a chaotic system — its extraordinary sensitivity to minute perturbations — usually permits only the coarse features to be demonstrated in practice. Mathematicians seek their prey among the fine details, and they have the promise of many seasons of good hunting. But science cannot remain aloof, for chaos, revealing as it does the limits to predictability, must ultimately affect the philosophy of science in general, as well as the private philosophies of individual scientists.

The authors of this introduction to the subject have sought to bridge the chasm between the modest mathematical skills of a science student and the rather appalling complexity of most writings about chaos, as well as the *art nouveau* of fractal geometry. With the help of copious computer drawings and elementary exercises they have succeeded in conveying basic concepts in a technically simple manner. The occasional lapses, such as the use in a single diagram of the symbol *f* to mean both a function of time and a frequency of oscillation, are only momentary distractions in an otherwise easily flowing argument which should not discourage even a timid novice.

Whether the novice will be actively encouraged is another matter, for I am not persuaded that the problem has been attacked from the best angle. Much of the development takes as exemplar the hard-driven pendulum. Excellent as an easily visualized model, the pendulum suffers the disadvantage of being governed by a differential equation that cannot be solved in terms of elementary functions. Thus one must rely on point-by-point numerical integration which, even with a large computer, makes the collection of data on the long-term behaviour a slow process. Moreover, a reader who knows how sensitive a chaotic system is to minute disturbances must wonder about the adequacy of the Runge-Kutta program to avoid artefacts; and nothing is said to allay his doubts. It would surely have been better to choose a model which allows one to proceed analytically, and therefore

enormously faster, from one point on a Poincaré section to the next. Balls bouncing on oscillating plates, and other impact oscillators, have this simplicity and are just as easily visualized; data generated with even a small desk computer verify some of the theoretical predictions more convincingly than seems to have been possible with the pendulum.

Although so much emphasis is placed on one special system, it does provide opportunities to illustrate many basic ideas — bifurcation, Lyapunov exponent, winding number, fractal dimension. The reader, however, may wonder why anyone bothers to introduce them as the all-too-brief final chapter, devoted to physical applications, gives (apart from bifurcation) no convincing example of their use. A mathematician can doubtless love these concepts for their own sake, but will a scientist find an incentive to take things further? Whoever is fired to do so must harbour no illusions; this gentle introduction gives scant warning of the arduous task to be undertaken by any who desire to achieve professional competence. □

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"Nothing has been so destructive to indigenous peoples as what we call progress. Mines, dams, roads, . . . and other expressions of 'economic development' have forced indigenous peoples from lands they have occupied for centuries. . . ." *The Gaia Atlas of First Peoples* by Julian Berger examines the way of life of the indigenous peoples of the world and the ecological, economic and political threats which they face. Publisher is Robertson McCarta, price is £13.95 (hbk), £8.95 (pbk). □