Gleick, James

Chaos. Making a new science. (English) Zbl 0706.58002
New York: Penguin Books. xi, 352 p. $ 11.95 (1987).

When faced with such a book, a reviewer could hardly refrain from using only superlatives. It is a stunning chonicle of the short history of a promising new science: chaos theory. The author, an outstanding science writer, exceptionally interweaves the accurate scientific explanation with entertaining anecdotes about the pioneers and with deeply exciting essays about the philosophy of science. Reading the book we live the conflicts and frustrations of the scientists, their emotions and moments of revelation.

The author records the birth of the new science in the 1970's, when a few scientists in the United States and Europe, mathematicians, physicists, biologists, chemists, all seeking connections between different kinds of irregularity, began to find a way of seeing order and pattern where formerly only the random, the erratic, the unpredictable had been observed: the shapes of clouds, the paths of lightning, the microscopic intertwining of blood vessels, the galactic clustering of stars.

When the pioneers of chaos began to think back on the genealogy of the new science, they found many intellectual trails from the past. Among these trails there was one that stood out clearly: the Butterfly Effect, i.e. the sensitive dependence on the initial conditions discovered by Edward Lorenz. It is the work of this "mathematician in meteorologist's clothing" to which James Gleick dedicates the first chapter of his book.

The features that impose chaos as a real revolution in thinking are outlined in the second chapter. The author stresses the impact that the work of the great mathematician Steve Smale had on the development of the ideas responsible for the birth of the new science. In fact, in an effort to understand chaos, it is hard to find a better starting point than the intuitive topological transformation known as "Smale's horseshoe".

The ecologists came to chaos via the study of the logistic difference equation and, perhaps, due to the friendship between Robert May, a biologist, an the mathematician James Yorke too. They were the first "to feel the shock of period-doubling and to pass this shock along to the community of scientists". In the third chapter of his book, James Gleick conjures up this significant step.

The 4th chapter introduces the framework created by Benoit Mandelbrot, the man who understood "The Fractal Geometry of Nature".

Benoit Mandelbrot provided an indispensable language and a catalogue of surprising pictures of nature. But, as Mandelbrot himself acknowledged, the framework he created "described better than it explained", while the physicists wanted to know more: they wanted to know why. So, it was to be the physicists who made a new science of chaos. The chapters entitled "Strange Attractors", "Universality" and "The Experimenter" consider the contributions of both theorists like David Ruelle, Floris Takens, Michel Hénon and Mitchell Feigenbaum and experimenters like Harry Swinney, Jerry Gollub and Albert Libchaber.

The "Images of Chaos" created by mathematicians like John Hubbard, Heinz-Otto Peitgen, Peter H. Richter and Michael Barnsley, of very significant help in order to better understand the behavior of dynamical systems, are considered in the 8th chapter of the book under review.

In the 1980's, at Santa Cruz University of California, four graduate students, Robert Shaw, Doyne Farmer, Norman Packard and James Crutchfield, succeeded to build the bridge between theory and experiment in chaos. In the 9th chapter, James Gleick tells the story of this group that came to call itself "The Dynamical Systems Collective".

The exceptional impact of chaos on biology and medicine was inferred by many scientists. In the 10th chapter, "Inner Rhythms", the author outlines the efforts made by Bernardo Huberman, Arthur Winfree and Arnold Mandell to fundament this new direction of research.

"Chaos and Beyond" is the title of the last chapter, in which James Gleick points out the ideas that form the basis of the new revolution in thinking: "simple systems give rise to complex behavior; complex systems give rise to simple behavior; the laws of complexity hold universally, caring not at all for the details of a system's constituent atoms". The author also stresses that the results obtained until now constitute only the foundation of this new and fast growing science called chaos and offers a short look

to a part of its current trends.

The book under review is an extremely useful introduction in chaos theory. The author not only explains accurately and skillfully the fundamentals of the new science but also sketches its history. For those who want to consider chaos thoroughly, the Notes on Sources and the Index offered at the end of the book will be of great help.

I was delighted to read this book and I would strongly recommend it to all those who like to understand the present day changes in the pattern of science.

Reviewer: D.Savin

MSC:

58-03	History of global analysis
37D45	Strange attractors, chaotic dynamics of systems with hyperbolic behavior
58-01	Introductory exposition (textbooks, tutorial papers, etc.) pertaining to global analysis
01-01	Introductory exposition (textbooks, tutorial papers, etc.) pertaining to history and biography

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butterfly effect; bifurcation; fractals; Mandelbrot set; Julia sets; chaos; Smale's horseshoe; period-doubling