

Klaus
Mainzer

Thinking in Complexity

The Complex Dynamics
of Matter,
Mind, and Mankind

With 118 Figures

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and 'Neuroinformatics' (1993–1994; Ma 842/6-1). I have received much inspiration from teaching in a mathematical graduate program on 'Complex Systems' (supported by the DFG) and an economic program on 'Nonlinearity in Economics and Management' at the University of Augsburg. In 1991 and 1993, the Scientific Center of Northrhine-Westphalia (Düsseldorf) invited me to two international conferences on the cultural effects of computer technology, neurobiology, and neurophilosophy.

Last but not least, I would especially like to thank J. Andrew Ross (Springer-Verlag) for carefully reading and correcting the book as a native speaker, and Katja E. Hüther and Jutta Janßen (University of Augsburg) for typing the text.

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Klaus Mainzer

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The theory of nonlinear complex systems has become a successful problem solving approach in the natural sciences – from laser physics, quantum chaos, and meteorology to molecular modeling in chemistry and computer-assisted simulations of cellular growth in biology. On the other hand, the social sciences are recognizing that the main problems of mankind are global, complex, and nonlinear, too. Local changes in the ecological, economic, or political system can cause a global crisis. Linear thinking and the belief that the whole is only the sum of its parts are evidently obsolete. One of the most exciting topics of present scientific and public interest is the idea that even our mind is governed by the nonlinear dynamics of complex systems. If this thesis of computational neuroscience is correct, then indeed we have a powerful mathematical strategy to handle interdisciplinary problems of natural sciences, social sciences, and humanities.

What is the reason behind these successful interdisciplinary applications? The book shows that the theory of nonlinear complex systems cannot be reduced to special natural laws of physics, although its mathematical principles were discovered and at first successfully applied in physics. Thus it is no kind of traditional 'physicalism' to explain the dynamics of laser, ecological populations, or our brain by similar structural laws. It is an interdisciplinary methodology to explain the emergence of certain macroscopic phenomena via the nonlinear interactions of microscopic elements in complex systems. Macroscopic phenomena may be forms of light waves, fluids, clouds, chemical waves, plants, animals, populations, markets, and cerebral cell assemblies which are characterized by order parameters. They are not reduced to the microscopic level of atoms, molecules, cells, organisms, etc., of complex systems. Actually, they represent properties of real macroscopic phenomena, such as field potentials, social or economical power, feelings or even thoughts. Who will deny that feelings and thoughts can change the world?

In history the concepts of the social sciences and humanities have often been influenced by physical theories. In the age of mechanization Thomas Hobbes described the state as a machine ('Leviathan') with its citizens as

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