

Preface

Nonlinear dynamics of complex processes is an active research field with large numbers of publications in basic research and broad applications from diverse fields of science. Nonlinear dynamics as manifested by deterministic and stochastic evolution models of complex behaviour has entered statistical physics, physical chemistry, biophysics, geophysics, astrophysics, theoretical ecology, semiconductor physics and -optics etc. This research has induced a new terminology in science connected with new questions, problems, solutions and methods. New scenarios have emerged for spatio-temporal structures in dynamical systems far from equilibrium. Their analysis and possible control are intriguing and challenging aspects of the current research.

The duality of fundamental and applied research is a focal point of its main attractivity and fascination. Basic topics and foundations are always linked to concrete and precise examples. Models and measurements of complex nonlinear processes evoke and provoke new fundamental questions and diversify and broaden the mathematical concepts and tools. In return, new mathematical approaches to modeling and analysis enlarge the scope and efficiency of applied research.

Fundamental research on complex physical systems, as well as applied interdisciplinary investigations of nonlinear dynamics, are valued highly in research programs and education of universities and research institutes in Berlin and Potsdam (Germany). Initiated by Werner Ebeling (Humboldt-University at Berlin) and Gerhard Ertl (Fritz Haber Institute Berlin) the

collaborative research has led to the foundation of the collaborative research center 555 of the German research society (DFG), 9 years ago. This center has stimulated cooperations between the different research groups in the region.

Recent progress on nonlinear complex processes in Berlin and Potsdam is presented in this volume. The topics of our research encompass

- spatio-temporal pattern formation in semiconductors, geophysical, astrophysical, chemical and electrochemical, biological and ecological system,
- the fundamental understanding of elementary structures and their interactions in deterministic and stochastic dynamics in two and three spatial dimensions,
- the role of global and nonlocal feedback and external forces in control of spatio-temporal pattern formation, with applications, e.g., to nonlinear chemical systems and semiconductor nanostructures,
- stochastic and coherence resonance and noise induced behaviour as manifestation of the constructive role of noise in supporting the existence of spatial and temporal structures with examples from semiconductors, chemical and neuronal systems and climatic dynamics,
- the microscopic stochastic modeling of dynamic cellular and intracellular processes as the propagation of Ca-waves above membranes and the action by neurons,
- the understanding of chaos synchronization and of stochastic synchronization,
- the manifold role and the many applications of delayed feedback in chaos control,
- the evidence of synchronization phenomena in population-, climatic and oceanic dynamics as well as their importance in optoelectronic devices.

All chapters were written in the spirit to convince students and outsiders

of the attractivity of studying complex nonlinear processes as well as to provide researchers of the field with new details and results. Thus all contributions contain longer introductions of the topic followed by new findings of our research.

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