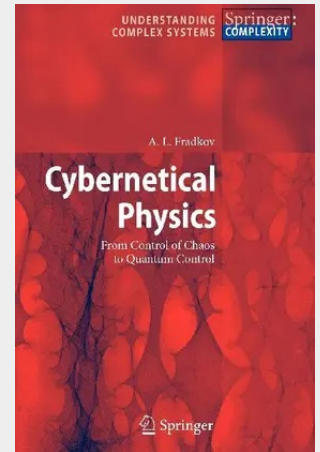


Cybernetical Physics

From Control of Chaos to Quantum Control

In this book a number of ideas and results related to the field of cybernetical physics – the scientific area aimed at the study of physical systems by cybernetical means – are presented. Although some publications in physical journals related to control problems appeared long ago, formation of a self-sustained area started as late as in the 1990s due to the explosion-like development of research in control of chaos, quantum control, and other areas. The number of publications has reached several thousands by the end of the century and it continues to grow very rapidly. This book is, perhaps, the first attempt to present a unified exposition of the subject and methodology of cybernetical physics as well as solutions to some of its problems. A part of this book presents the limits of system transformation by means of control both for conservative and for dissipative systems based on Hamiltonian description of system dynamics. A survey of various control applications in physics is given: control of chaos, controlled synchronization, control of spatiotemporal systems, control of molecular and quantum systems. An approach for building models of system dynamics based on control methods is discussed. The presented methods and results are illustrated by examples of new approaches to classical problems: Stephenson–Kapitsa pendulum, escape from a potential well, synchronization of coupled oscillators, control of chemical reaction with phase transition, controlled dissociation of molecules, controlled oscillations of complex crystalline lattices. Controlled pendulums appear in many parts of the book since pendulum models can be thought of as the “atoms of nonlinear physics”.

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