Preface

The discovery of chaos and the first contributions to the field date back to the late 19th century with Poincaré's pioneering studies. Even though several important results were already obtained in the first half of the 20th century, it was not until the '60s that the modern theory of chaos and dynamical systems started to be formalized, thanks to the works of E. Lorenz, M. Hénon and B. Chirikov. In the following 20–25 years, chaotic dynamics gathered growing attention, which led to important developments, particularly in the field of dynamical systems with few degrees of freedom. During the mid '80s and the beginning of the '90s, the scientific community started considering systems with a larger number of degrees of freedom, trying to extend the accumulated body of knowledge to increasingly complex systems. Nowadays, it is fair to say that low dimensional chaotic systems constitute a rather mature field of interest for the wide community of physicists, mathematicians and engineers. However, notwithstanding the progresses, the tools and concepts developed in the low dimensional context often become inadequate to explain more complex systems, as dimensionality dramatically increases the complexity of the emerging phenomena. To date, various books have been written on the topic. Texts for undergraduate or graduate courses often restrict the subject to systems with few degrees of freedom, while discussions on high dimensional systems are usually found in advanced books written for experts. This book is the result of an effort to introduce dynamical systems accounting for applications and systems with different levels of complexity. The first part (Chapters 1 to 7) is based on our experience in undergraduate and graduate courses on dynamical systems and provides a general introduction to the basic concepts and methods of dynamical systems. The second part (Chapters 8 to 14) encompasses more advanced topics, such as information theory approaches and a selection of applications, from celestial and fluid mechanics to spatiotemporal chaos. The main body of the text is then supplemented by 32 additional call-out boxes, where we either recall some basic notions, provide specific examples or discuss some technical aspects. The topics selected in the second part mainly reflect our research interests in the last few years. Obviously, the selection process forced us to omit or just briefly mention a few interesting topics, such as random dynamical systems, control, transient chaos, non-attracting chaotic sets, cellular automata and chaos in quantum physics.

The intended audience of this book is the wide and heterogeneous group of science students and working scientists dealing with simulations, modeling and data analysis of complex systems. In particular, the first part provides a self-consistent undergraduate/graduate physics or engineering course in dynamical systems. Chapters from 2 to 9 are also supplemented with exercises (whose solutions can be found at: http://denali.phys.uniroma1.it/∼chaosbookCCV09) and suggestions for numerical experiments. A selection of the advanced topics may be used to either focus on some specific aspects or to develop PhD courses. As the coverage is rather broad, the book can also serve as a reference for researchers.

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