Preface

Over the last fifteen years an important research activity has been devoted to the dynamics of coupled and driven chaotic oscillators. This is still an active field of research; however, a considerable body of knowledge has already been established. This is mainly, but not exclusively, in the form of research papers in physics and mathematics journals. These results are of interest for scientific analysis and explanation in all scientific disciplines, as well as for possible application in medicine and engineering. The purpose of this book is to provide a systematic and broad account of that research for a wide audience. This will be achieved by a selection of the most basic theoretical results, as well as experiments and applications to be presented at a mathematical level accessible for people working in non-hard sciences. This, however, does not exclude physicists and mathematicians looking for an introduction to the field.

Resonance and normal modes of vibration are well known classical phenomena observed in driven and coupled linear harmonic oscillators, which have a great relevance in all the natural sciences and in engineering. Since the last quarter of the twentieth century the study of chaotic oscillators has emerged as an object of great interest in physics and mathematics. In view of the importance that the classical results for the dynamics of driven, or coupled harmonic oscillators, has achieved in science and technology, the question of which phenomena emerge when chaotic oscillators are coupled or somehow driven or perturbed has been, and is of great interest. The most relevant phenomena studied until now are the synchronization and the suppression of chaos. This book is aimed to provide a brief account of these investigations. The approach used considers different schemes of driving or coupling. For each of these set-ups, the phenomena that occur are

studied, and experiments that show that these phenomena are observable in the real world are discussed.

The first two chapters, which deal with the theory of oscillators, harmonic and chaotic, are aimed to provide the reader with basic concepts on dynamical systems and chaos theory needed to follow the rest of the book. In the next five chapters, the different scenarios which emerge when chaotic oscillators are externally driven or mutually coupled are studied. These include a variety of forms of chaos synchronization, which are systematically defined and characterized; as well as several conditions, and procedures which lead to taming chaos; i.e., to turn the chaotic motion to periodic. Moreover, throughout these seven chapters, by means of examples borrowed from different disciplines, the multidisciplinary nature of the subject will be illustrated. In the last chapter, a general vision of the field of synchronization and control of chaos is given by means of a summary, and examples of application of this body of knowledge in science and technology are presented to sustain a discussion of perspectives for the future.

The didactical approach followed throughout the book combines tutorial and review techniques. For each scientific issue studied, the basic concepts and techniques are explained in detail and immediately exemplified by means of numerical simulations made with simple, but significant models. This is followed by the presentation of a brief review and discussion of experimental realizations and numerical simulations. The former will show that the theory introduced is meaningful in the real world, and the latter will expand the scope of the theory and examples previously posed. All the above is provided together with a bibliography aimed to allow the reader to probe deeper into the particular issues that especially interest him or her.

I have been working on coupled and driven chaotic oscillators for the last ten years. The view presented in this book, has been shaped during my experience with the development of my own research and the interaction with many colleagues, whom I want to acknowledge and thank. I also gratefully acknowledge the financial support from DGI which allowed the scientific activity that has made this book possible.

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