Preface

Dynamical systems is the mathematical study of long-term behavior in systems that evolve in time, usually under unchanging rules. The broadness of this description corresponds to the multitude of specialties within dynamics that make up its contemporary spectrum of research. This volume presents a broad picture of many of the core areas in the mathematical theory of dynamical systems through surveys by a diverse group of leading experts.

Six of the volumes from the dynamical systems series and the mathematical physics series of Springer's Encyclopaedia of Mathematical Sciences constitute a project comparable in size to the present volume and its forthcoming companion Volume 1B. There are substantial differences in the choice of subjects and in the structure. The separation into multiple smaller volumes with different editors allows the Encyclopaedia to represent a variety of insights and points of view. A distinctive feature of our project is that the size of the volumes and the single editorship allows to combine the presentation of a wide spectrum of subjects with significant coordination and coherence. Indeed, we deemed it necessary to contribute the introductory survey "Principal Structures" to delineate with some care a framework within which these research areas can be placed. While each survey can stand on its own, our introductory survey introduces mathematicians from other disciplines to the field of dynamical systems and provides a context that will hopefully serve to enhance the appreciation of the individual surveys.

The introductory survey emphasizes to the extent possible the structural approach characteristic for large parts of modern mathematical research and exposition. We classify and describe disciplines within dynamical systems according to the underlying structure which is preserved by dynamical evolution: measurable (ergodic theory), topological (topological dynamics), differentiable (differentiable dynamics, often called the theory of smooth dynamical systems), symplectic and its variations (Hamiltonian, Lagrangian and contact dynamics, which all grew out of the mathematical problems of classical mechanics), and algebraic (homogeneous dynamics). Within differentiable dynamics, which occupies a central place in the majority of surveys in this volume, we emphasize the principal paradigms of asymptotic behavior: elliptic (slow orbit growth and stability), parabolic (intermediate orbit growth), hyperbolic (exponential behavior) and partially hyperbolic (mixed behavior dominated by hyperbolic phenomena).

Some important areas are not represented in the volume or are mentioned only briefly; holomorphic dynamics is a prime example. This is partly explained by space limitations and partly by the distribution of the material between various volumes of the series (e.g., holomorphic dynamics is discussed in the bifurcations volume). Some of the omissions will be filled in Volume 1B, which will appear in the near future. There are other important

areas of dynamics that are not represented in a survey of their own but are treated with some care in our introductory survey. As an important part of the general structural approach, topological dynamics is a prime example.

We would like to thank the authors of the surveys in this volume for investing their time so generously in this project, and for writing surveys of such high quality. Numerous other mathematicians took interest in the project and read drafts of various surveys or their major portions. This resulted in numerous valuable suggestions. This interest also provided great encouragement for the authors and editors and helped to bring this extensive project to successful completion. We are also indebted to Kathleen Hasselblatt and Svetlana Katok for their support and patience while we worked on this volume.

The field of dynamical systems came into being in the late 19th century. For a brief historical account of the development of the field arranged by its major subdivisions an interested reader may consult Section 1 of Chapter 0 in our book "Introduction to the modern theory of dynamical systems" published by Cambridge University Press in 1995.

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