

# Preface

The foundations of the theory of semigroups of operators were established in the first half of the twentieth century as a formalization of the view emphasized by A. Hadamard that an autonomous deterministic system is described by a one-parameter semigroup of transformations. Hence, the theory was first designed as a functional analytic language of partial differential equations but soon also proved to be an important tool in stochastic processes, involving mathematicians like W. Feller in developing its basics. One could say that the theory of semigroups reached its maturity in the fourth and fifth decades of the previous century, when the major generation theorems were established thanks to the work of K. Yosida, E. Hille, R.S. Phillips, I. Miyadera, and, of course W. Feller. It attained its first apex with the publication of the famous book *Functional Analysis and Semi-Groups* by E. Hille and R.S. Phillips, which reflected its predominantly functional-analytic character. Since then, semigroup theory has been rapidly developing as a theory “in itself”, posing new and fascinating internal questions, but also it has been reaching out to applications ranging from the classical ones such as partial differential equations and stochastic processes to less standard such as integro-differential and functional-differential equations, quantum mechanics, population biology, or control theory. Furthermore, though inherently linear and autonomous, semigroup theory proved indispensable in describing both nonlinear and nonautonomous evolutionary phenomena. Thanks to intensive research, the theory reached some state of perfection in the last decades of the previous century and the wealth of the amassed results, both theoretical and applied, has been reflected in a series of excellent books presenting the state of the art in the field and complementing the fundamental treatise of E. Hille and R.S. Phillips. These include monographs by E.B. Davies, A. Belleni-Morante, A. Pazy, J.A. Goldstein, and K.J. Engel and R. Nagel, which present the functional analytic point of view, and by S.N. Ethier and T.G. Kurtz, W. Feller and E.B. Dynkin, which are instrumental in understanding the role of semigroups in Markov processes. These authors were largely responsible for bringing the theory to the current state and we are pleased to note that a survey paper of J.A. Goldstein and R. Nagel is one of the cornerstones of the presented volume.

In the opinion of the editors of this volume, the recent years have witnessed an even increasing intertwining of applied and pure aspects of the theory. Semigroup methods, often in competition with other approaches, have been successfully applied in concrete problems encountered, e.g., in various branches of mathematical biology (including population dynamics, population genetics, coagulation and fragmentation processes, signaling pathways, etc.) which, in turn, have inspired the development of new mathematical methods and important discoveries in the field. At the same time, despite the fact that semigroup theory was considered to be almost complete in the 1980s, its core has been continually enlarged far beyond the expectation to include, for instance, the theory of positive semigroups, long-term behavior of semigroups (including chaotic dynamics), systematic treatment of boundary conditions, or generation theorems for cosine families, which have found important applications.

It has been, however, felt that the exchange of the results between various communities that use semigroup methods have been too slow, possibly due to often hermetic languages used in particular applications. The conference was therefore meant as a forum for mathematicians using the theory of semigroups to meet and talk about the problems they have been working on. For those who were working on its pure aspect, this was a chance to present their theoretical results and learn of the developments and challenges in applied branches. And vice versa—those working on applied problems were able to put their work in the more general context and learn of the new discoveries in other fields. The fact that at the same time we could celebrate the 80th birthday of Prof. Jan Kisiński, who has played an essential role in the development of the theory and bringing together its probabilistic and analytic aspects, gave the conference another dimension.

The conference brought together 107 participants from 16 countries, who presented five plenary and 86 contributed talks. This volume contains 21 talks that have undergone strict refereeing process before being accepted. While not pretending to have covered any significant part of the field, the editors nevertheless believe that the presented selection will give the reader a glimpse of this fascinating area of research, from a classical survey of the history of the theory and its applications, through the discussion of some pertinent theoretical questions, to applications in control theory, financial models, quantum mechanics and other applied disciplines.

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