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Edited by Karl E. Petersen and Ibrahim A. Salama

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Ergodic Theory and its Connections with Harmonic Analysis

Proceedings of the 1993 Alexandria Conference

Edited by

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and

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PREFACE

Ergodic theory is a crossroads for many branches of mathematics and science, from which it has drawn problems, ideas, and methods, and in which it has found applications.

In recent years the interaction of ergodic theory with several kinds of harmonic analysis has been especially evident: in the Fourier method of proving almost everywhere convergence theorems introduced by Bourgain and developed by Rosenblatt, Wierdl, and others; in the application of the real-variable harmonic analysis of the Stein school to ergodic theory by, for example, Bellow, Boivin, Deniel, Derriennic, Jones, and Rosenblatt; in rigidity theory, where Katok, Margulis, Mostow, Ratner, Spatzier, Zimmer, and others blend ergodic theory with dynamics, noncommutative harmonic analysis, and geometry; in the study of singular measures, spectral properties, and subgroups by Aaronson, Host, Méla, Nadkarni, and Parreau, which has furthered the analysis of nonsingular transformations and has led to progress on old problems like the higher-order mixing conjecture; in the structure theory of single transformations, where concepts like rank, joinings, and approximation are helping workers such as del Junco, King, Lemanczyk, Rudolph, and Thouvenot to classify systems, to understand better the important family of Gaussian processes, and to explore the connections among spectral and dynamical properties; in the combinatorics of adic transformations, introduced by Vershik and pursued by Herman, Kerov, Livshitz, Putnam, and Skau, which makes visible the connections between some invariants of dynamical systems and certain C^* -algebras, especially those associated with group representations; and in the applications of ergodic theory to combinatorial number theory and Diophantine approximation discovered by Furstenberg and developed also by Bergelson, Hindman, Katznelson, and Weiss, which rely in an essential way on techniques from harmonic analysis and spectral theory.

Egypt is a crossroads of many cultures and peoples, convenient to the countries of the Middle East, Africa, and Europe, and roughly equidistant from Asia and America. Our conference, focussed on the interaction of ergodic theory with harmonic analysis, found a natural site in Alexandria, the home of Euclid, Diophantus, Hypatia, Ptolemy, . . . (some of whom we could try to claim as early ergodic theorists—Ptolemy, in his celestial mechanics, perhaps even as someone who applied harmonic analysis to dynamics). While no attempt was made to cover the area completely, some important sectors were described in survey talks, and the research talks reported interesting new developments.

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Part I of these Proceedings contains three survey articles expanding presentations given at the conference. Each gives an up-to-date description of an area of lively interaction of ergodic theory and harmonic analysis, laying out the background of the field and the sources of its problems, the most important and most interesting recent results, and the current lines of development and outstanding open questions. These papers—by Rosenblatt and Wierdl on Fourier methods in almost everywhere convergence, by Spatzier on rigidity, and by Thouvenot on joinings—should provide convenient starting points for researchers beginning work in these areas.

Part II is a collection of refereed research papers presenting new results on questions related to the theme of the conference. Some of these papers were presented at the meeting, others were contributed later. Two of them (Lesigne, Rudolph) concern the problems in noncommutative harmonic analysis that emerge in trying to understand the nonlinear ergodic averages arising from Furstenberg's diagonal approach to Szemerédi's Theorem, and three others (Forrest, Hendrick, and McCutcheon) treat further developments in this dynamical multiple-recurrence theory. The remainder deal with problems in almost everywhere convergence and a variety of other topics in dynamics.

It is a pleasure to thank the many people and institutions who contributed to the success of the conference and to the preparation of these Proceedings. The National Science Foundation and Institute of Statistics of Cairo University provided financial support. Special thanks are due to Professor Ahmed E. Sarhan and Professor Mahmoud Riad for their hospitality and handling of the official arrangements in Egypt. We also thank Professor Mounir Morsy for welcoming us to his Department of Mathematics at Ain Shams University. Further, we are indebted to the anonymous referees, who improved the papers presented here beyond their original versions, to the many excellent typists who produced the \TeX files, and to Lauren Cowles and David Tranah, who smoothly handled the publishing.

Karl Petersen and Ibrahim Salama
Chapel Hill, N.C.
July 11, 1994

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