PREFACE

This volume contains the proceeding of the National Research Symposium on *Geometric Analysis and Applications* held at the Centre for Mathematics and its Applications, Australian National University, Canberra, from June 26 – 30, 2000. The Symposium celebrated the many significant contributions of Professor Derek W. Robinson to mathematics, on the occasion of his 65th birthday. The first day, Monday June 26, in particular was devoted to Derek; speakers with a particularly close connection to Derek, including A. Carey, M. Cowling, D. Evans, P. Jorgensen and T. ter Elst recalled and elaborated on important aspects of Derek's work, and the day ended with a banquet in Derek's honour.

The Symposium brought together researchers working in harmonic analysis, linear and nonlinear partial differential equations, quantum mechanics and mathematical physics, and included researchers from North America, Europe and Asia as well as Australasia.

We gratefully acknowledge the support of the contributors to this volume. We would like especially thank to Derek W. Robinson for his participation. A short synopsis of Derek's career, and a full list of his publications to date are included in this volume.

Contributions for the proceedings were sought from all participants and all papers received were carefully refereed by peer referees.

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(Editors)

At the end of 2000 Derek Robinson retired from his position as Professor of Mathematics in the Institute of Advanced Studies at ANU, a position he had held for 19 years. Robinson obtained his early training at Oxford with a Bachelor's degree in mathematics in 1957 and a Doctorate of Philosophy in theoretical nuclear physics in 1960. Subsequently he held various post-doctoral positions in Switzerland, the United States, Germany and France before being appointed Professor of Mathematical Physics at the University of Aix–Marseille in 1968. He remained in this position until 1978 at which point he accepted appointment as Professor of Mathematics at the University of New South Wales. Soon after he moved to Australia he became a Fellow of the Australian Academy of Science.

In his early years Robinson worked in a wide range of areas of mathematical physics, quantum field theory, statistical mechanics, operator algebras, etc. Operator algebras were introduced into quantum field theory in the 1960s as a means to describe the macroscopic observables but their most fruitful application was to the characterization of the equilibrium states of statistical mechanics. The observables of classical statistical mechanics form an abelian C^*-algebra and Robinson realized that the corresponding quantum algebra was 'asymptotically abelian'. This observation was of fundamental importance since the states of asymptotically abelian algebras could be shown to share many of the good properties of abelian algebras. Therefore extremal states of the algebra could be identified with pure phases of the system and decomposition theory of the states could be applied to describe the separation of the phases. Although these results were of a general abstract nature Robinson showed that they could be applied to a broad class of realistic models of quantum spin systems. In particular he demonstrated that a number of these systems exhibited a phase transition at low temperatures and the pure phases were indeed described by extremal invariant states. Much of this is described in the two volume monograph Operator Algebras and Quantum Statistical Mechanics which Derek Robinson co-authored with Ola Bratteli. Both volumes of this book appeared in a second edition and continue to be used by research workers in these areas twenty years later.

The majority of applications of operator algebras to quantum statistical mechanics concerned the equilibrium theory. Robinson and Bratteli realized that the description of non-equilibrium phenomena required a dynamical theory and this in turn required a theory of unbounded derivations of the algebras. The foundations of this theory were laid in a series of joint papers which are also described in their book. As a direct result of this latter work Robinson's interests then developed to evolution equations and semigroup

theory in a much broader context. This change of direction coincided with his move to Australia and most of his subsequent work has been on evolution equations, in particular equations involving elliptic operators on Lie groups.

One of the issues at that time was the integrability of a Lie algebra representation. Together with Ola Bratteli, George Elliott and Palle Jørgensen, Robinson gave a sufficient condition in terms of a dissipativity condition and an estimate on the semigroup generated by a Laplacian. Using Lipschitz spaces Robinson could not only weaken the assumptions in the above mentioned paper, but he could also prove that the analytic vectors associated with any representation of a Lie group coincide with the analytic elements of the Poisson semigroup. By this stage Robinson became more interested in elliptic operators on Lie groups and decided to write the monograph Elliptic Operators and Lie Groups. After completion of the book Robinson began a collaboration with Tom ter Elst and their continuing work can be divided into three parts.

First, they developed the theory of complex, weighted, higher order subcoercive operators on Lie groups, in particular proving Gaussian bounds for the kernel, and its derivatives, of the semigroup generated by such an operator. They established that the Gaussian bounds are equivalent with a subcoercivity condition on the operator, under weak additional assumptions. Secondly, they studied second-order divergence form subelliptic operators on Lie groups with complex bounded measurable coefficients and proved, under a variety of conditions, optimal smoothness properties of the kernel. Thirdly, in joint work with Adam Sikora or Nick Dungey, they studied asymptotic properties of the semigroup and its kernel. They showed that on a Lie group with polynomial growth the second-order Riesz transforms associated with the Laplacian are bounded if, and only if, the group is a direct product of a compact and a nilpotent Lie group. Their analysis of the asymptotics of higher order operators continues.

Robinson has maintained an active involvement in University affairs, having been Chairman of the Board of the Institute for Advanced Studies at ANU (1988-1992), and a member of ANU Council (1997-2000), where he never resiled from robust and provocative debate. He has also been an active member of the mathematical community, in particular being president of the Australian Mathematical Society (1994-1996) and continuing as Vice-president. He also served four years as a member of the Research Training and Careers Committee of the ARC (1996-2000) and as Chair of the National Committee for Mathematics (1997-2001).