Infinite Dimensional Algebras and their Applications to Quantum Integrable Systems

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PREFACE

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This special issue is centred around the workshop Infinite Dimensional Algebras and Quantum Integrable Systems II—IDAQUIS 2007, held at the University of Algarve, Faro, Portugal in July 2007. It was the second workshop in the IDAQUIS series following a previous meeting at the same location in 2003. The latest workshop gathered around forty experts in the field reviewing recent developments in the theory and applications of integrable systems in the form of invited lectures and in a number of contributions from the participants. All contributions contain significant new results or provide a survey of the state of the art of the subject or a critical assessment of the present understanding of the topic and a discussion of open problems. Original contributions from non-participants are also included.

The origins of the topic of this issue can be traced back a long way to the early investigations of completely integrable systems of classical mechanics in the fundamental papers by Euler, Lagrange, Jacobi, Liouville, Kowalevski and others. By the end of the nineteenth century all interesting examples seemed to have been exhausted. A revival in the study of integrable systems began with the development of the classical inverse scattering method, or the theory of solitons. Later developments led to the basic geometrical ideas of the theory, of which infinite dimensional algebras are a key ingredient. In a loose sense one may think that all integrable systems possess some hidden symmetry. In the quantum version of these systems the representation theory of these algebras may be exploited in the description of the structure of the Hilbert space of states.

Modern examples of field theoretical systems such as conformal field theories, with the Liouville model being a prominent example, affine Toda field theories and the AdS/CFT correspondence are based on algebraic structures like quantum groups, modular doubles, global conformal invariance, Hecke algebras, Kac-Moody algebras, Virasoro algebras etc. The exploitation of these mathematical structures inevitably leads to a deeper understanding of the physical systems.

This issue provides some further progress in the investigations of the algebraic structures, such as Lie groups and Lie algebras, quantum groups, algebroids, etc, which have always played an important role in the development of the field. Quantum groups, for instance, have given an algebraic shape to the kinematics of the quantum inverse scattering method and these ideas are developed further in this issue.

Some contributions focus on integrable systems with boundaries, which are interesting in their own right from a formal point of view as they exhibit some peculiarities which cannot be found within systems with periodic boundary conditions. The reflection equations and underlying quantum group covariant algebras allow for meaningful generalisations of results found in integrable scattering theories. Meanwhile the off shell structures have also been developed further and the first examples for form factor calculations, ultimately leading to correlation functions, are presented in this issue.

Non-Hermitian Hamiltonian systems have already featured for some time in the context of integrable models, as for instance in the form of affine Toda field theories with a complex coupling constant or the Yang-Lee model. However, a systematic study of such types of models has only been initiated recently. It is now well understood that the reality of the spectrum of these models can be attributed either to the unbroken PT-symmetry of the entire system or to its pseudo(quasi)-Hermiticity. In reverse, one may take these concepts as starting points for the construction of new types of models, such as integrable ones which are the central topic of this special issue.

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We hope that this issue will provide a comprehensive insight into the theory of integrable systems for the newcomer to the field as well as to the expert.

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