Name: Ralph WILLOX

Research field: Applied Mathematics

Keywords: Mathematical Physics, nonlinear dynamical systems, integrable systems, discrete systems, cellular automata

Present research:

A major part of my research activity focuses on the study of nonlinear integrable systems and their algebraic properties, as well as on the construction of classes of particular solutions to such systems and the algebraic methods required for that purpose. I am particularly interested in discrete integrable systems (discrete in space and time) as these systems often encompass a multitude of integrable systems (including the continuous ones) in certain limits. A special limit that can be performed on certain discrete systems, the ultradiscrete limit, allows one to obtain cellular automata that can exhibit soliton-like behaviour. As it turns out, these solitonic cellular automata are related to (quantum) solvable lattice models, at their zero temperature limit. The rôle so-called Yang-Baxter maps play in this connection, as well as the extension of symmetry-based techniques such as Darboux or Bäcklund transformations to the ultradiscrete case are also an important research topic. At the moment however, the better part of my research time is dedicated to the study of integrability detectors for discrete systems, especially for birational maps, and to the study of the properties of their singularities.

I am also interested in possible applications of discretisation and ultradiscretisation techniques, originally developed in the context of integrable systems, to non-integrable dynamical systems, with the aim of constructing discretisations that exhibit the same dynamics as the original continuous systems over a vast range of the discretisation parameters.

Advice for students:

Besides general undergraduate level mathematics, some rudimentary knowledge of Lie algebras and of the theory of differential equations in the complex domain is required. Although basic skills in theoretical physics – classical field theory and quantum mechanics in particular – might prove useful, such knowledge can in principle also be acquired while studying a specific research problem.