Name:	Ralph WILLOX
Research field:	Applied Mathematics
Keywords:	Integrable systems, nonlinear dynamical systems, discrete systems, cellular automata

Present research:

A major part of my research activity focuses on the study of nonlinear integrable systems and of their algebraic properties, as well as on the construction of particular classes of solutions for integrable systems and on 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 limiting procedure that can be performed on such discrete systems, the so-called ultradiscrete limit, allows one to obtain cellular automata that, for example, 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 important research topics.

I also study possible applications of discretisation and ultradiscretisation techniques, originally developed in the context of integrable systems, to non-integrable dynamical systems. The aim being to construct discretisations that exhibit – over a vast range of the discretisation parameters – the same dynamics as the original continuous systems, in which case at the ultradiscrete limit one can obtain cellular automata that preserve the essential dynamics of the continuous systems.

Notice for the 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 – will prove useful, such knowledge can in principle also be acquired while studying a specific research problem.