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Introduction to Peter Kloeden's Special Issue

This special issue is intended as a first modest homage to Peter Kloeden on the occasion of his 60th birthday. Undoubtedly, Peter will be honoured with a variety of other publications and events. We would like to dedicate this issue to him in order to encourage him to continue for, at least, another 60 years of enlightening and fascinating scientific contributions.

As it is virtually impossible to discuss all these important works of Peter in Mathematics and in Science in general, we will only give a brief summary highlighting his most important contributions.

Peter has broad interests in all kinds of differential equations as well as in dynamical systems and their applications, fields in which he is regarded as a mathematical pioneer.

His doctoral thesis (Ph.D. 1975 University of Queensland; D.Sc. 1995) on set valued dynamical systems provided early contributions to chaos theory, showing that chaotic mappings are dense in the space of continuous functions. This contained the idea of microchaos, generalizing Sharkovsky's cycle co-existence ordering to higher dimensional triangular mappings. From the mid 1970s to the mid 1980s he made important early contributions to mathematical meteorology, especially concerning well posedness, existence and uniqueness issues for the quasi-geostrophic equations, a work which had influential effect on numerical practice in meteorology.

Around the same time, he wrote a couple of papers on fuzzy sets and dynamical systems which are considered the earliest serious mathematical studies in this field. Together with Phil Diamond (University of Queensland), Peter wrote a series of highly cited papers on fuzzy metric spaces which led to their influential book on the subject (World Scientific 1994).

Professor Kloeden spent sabbaticals at the Meteorology Department of the Pennsylvania State University (1981), at the University of Bremen (1985, 1988) and at Caltech (1985). With Robert Wells of Penn State he gave the first explicit example of a Hopf bifurcation in fluid mechanics (spinning off the zero solution in a rotating Benard problem, Proc. Roy. Soc. 1985) and with Jens Lorenz (then Caltech) he wrote a paper on the numerical approximation of attractors (SIAM J. Numerical Analysis 1986) which is widely regarded as a milestone in the development of numerical dynamics.

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Since 1980, Peter regularly visited Ludwig Arnold in Bremen and played a key role in the development of the theory of random dynamical systems (see Arnold's Springer Book 1998). Motivated by the need to have suitable numerical methods to explore random dynamics, Ludwig introduced him to Eckhard Platen with whom he wrote the by now well known seminal book on numerics for stochastic differential equations (Springer 1992). This book filled a huge scientific gap and established an important research area which substantially influenced numerics and stochastic alike. The book is still 'the' reference for numerics of stochastic differential equations and started a whole industry of new developments and applications, for instance in computational finance, again considerably influenced by Peter.

Professor Kloeden has written many papers on the approximation of random dynamical systems, ordinary and stochastic differential equations, filtering with fractional Brownian motion, the approximation of invariant measures through Markov chains for both deterministic and random systems, etc. Yet, Peter's biggest scientific efforts during the last 30 years were dedicated to the theory of dynamical systems and their applications. There is hardly an aspect in the theory of dynamical systems (stability, control, attractors, bifurcations, fuzzy dynamical systems, numerics and discretization, stochastic stability, chaos) or an application area to which Peter did not make a substantial contribution. A distinctive feature is that in all these areas his work ranges from the theoretical foundations to relevant applications or, as he himself might put it, 'from abstract nonsense down to numbers' – or vice versa. His enormous mathematical productivity is also reflected by the remarkable fact that he has over 100 coauthors, so far!

Since moving to Germany in 1997 he has focused on nonautonomous dynamical systems, both random (i.e. driven by random processes) and topological (e.g. driven by almost periodic processes). While his initial motivation was to investigate the numerical dynamics of these systems, along the way a lot of basic theory had to be developed. This resulted in the concepts of random and nonautonomous attractors – now known as pullback attractors – and the investigation of their properties as well as in the development of a bifurcation theory of nonautonomous such systems. These results have numerous applications such as to synchronized, switching and control systems.

In 2005, Peter was awarded the W. T. and Idalia Reid prize by the Society for Industrial and Applied Mathematics (SIAM) for his fundamental contributions to the theoretical and computational analysis of differential equations, and recently he has been elected as a Fellow of SIAM. There is no doubt at all that these will only be the first of many other prizes and distinctions Peter will receive in the future.

From our personal point of view, we have been enjoying his scientific ideas as well as his friendship and humour over the last years and we thank him for all.

Happy 60th birthday!

Sevilla
Bayreuth, May 2009

Tomás Caraballo
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