



Mathematics & Mathematics Education Seminar



4 MARCH 2026

WEDNESDAY

2.15 to 3.15 pm



MATH LAB 2 (NIE7-B1-04)

On the Efficiency of Modified Patankar-Runge-Kutta Methods for Convection-Diffusion-Reaction Equations

Mathematical modeling leads to so-called convection-diffusion-reaction equations in the form of systems of partial differential equations in numerous practical applications. Examples are turbulent air flows or algae growth in oceans or lakes. After discretization of the spatial derivatives, an extremely large system of ordinary differential equations occurs. A reasonable numerical time integration scheme must reflect present properties like the positivity of single balance quantities or also the conservativity of the initial model. In the talk we will present so-called modified Patankar-Runge-Kutta (MPRK) schemes. They adapt explicit Runge-Kutta schemes in a way to ensure positivity and conservativity irrespective of the time step size. Thereby, we introduce a general definition of MPRK schemes and present a thorough investigation of necessary as well as sufficient conditions to derive first, second and third order accurate MPRK schemes. The theoretical results will be confirmed by numerical experiments in which MPRK schemes are applied to solve non-stiff and stiff systems of ordinary differential equations. Furthermore, we investigate the efficiency of MPRK schemes in the context of convection-diffusion-reaction equations with source terms of production-destruction type.

Speaker's Biography

Prof. Andreas Meister studied Mathematics and Computer Sciences at the University of Göttingen and received his Diploma in 1993. From 1993 to 1996 he worked at the Institute of Theoretical Mechanics of the German Aerospace Research Establishment and got his doctoral degree (Dr.rer.nat.) from the Technical University of Darmstadt in 1996. After working as a Research Scientist for the Fraunhofer Institute of Industrial Mathematics in Kaiserslautern he became an Assistant Professor at the University of Hamburg, where he finished his Habilitation in 2001. Afterwards he was appointed Professor at the Medical University of Lübeck in 2002 and became a Full Professor of Applied Mathematics at the University of Kassel in 2003. He received the Kurt-Hartwig-Siemers-Price for research in 2000, the Mentorship-Price of the Claussen-Simon-Foundation in 2002, the Best Teacher Award of the University of Hamburg in 2000 and 2001 as well as the Teaching Award of the Student Council of the Medical University of Lübeck in 2003. Recently in 2018, he was awarded together with Prof. Rita Borromeo Ferri with the State of Hesse Award for Excellence in University Teaching. His research area is in the field of numerics of ordinary and partial differential equations with a special focus on real life applications, and he is the author of more than 10 textbooks and well over a hundred scientific publications. Furthermore, in 2022 Andreas is awarded as a STEM-Ambassador from the German national STEM-Association. Andreas is the Co-founder and leader of the STEM-Hub at University of Kassel.



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