Lagrangian and Eulerian Methods for Generalized Advection-Diffusion

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SUNYIT Utica/Rome

We study stationary and transient advection diffusion equations for differential forms and their Lagrangian and Eulerian discretization by means of discrete differential forms. The discretizations with discrete differential forms provide models both for the classical scalar advection diffusion equation as well as for the transport of magnetic fields in moving conducting fluids (magnetohydrodynamics). The challenge is robustness and optimal a priori error estimates in the case of vanishing diffusion. Exterior calculus involving the Lie derivative will be harnessed to achieve streamlined formulations and sharper a priori convergence estimates.

Holger Heumann received his PhD in Mathematics from Swiss Federal Institute of Technology in Zurich (ETH) in 2011, where he developed and implemented efficient multigrid methods or stable mixed finite element methods for magnetohydrodynamics. For this he used exterior calculus of differential forms, a coordinate free approach to multivariable calculus invented by E. Cartan a century ago, which has recently received much attention in the construction of structure preserving numerical methods. At the LRC Fusion in Nice (France) he contributed to the development of software for plasma and nuclear fusion simulations. Currently he is visiting professor at Rutgers University (NJ). Dr. Heumann works with Ralf Hiptmair, Jacques Blum, Michael Vogelius, he was Oberwolfach Leibniz Graduate Student and was awarded a fellowship by the Chinese University of Hong Kong. He was also the Lead developer of LehrFEM, a Matlab finite element library for teaching numerical mathematics.

Invited by Andrea Dziubek and Edmond Rusjan, Applied Mathematics