Karlsruher Institut für Technologie

Die Dozenten des Schwerpunktes
Partielle Differentialgleichungen

Karlsruher PDE-Seminar

Numerical analysis of operator splitting methods

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Splitting methods form a large class of competitive time discretisations of evolution equations. The reason for their frequent use is that the splitting procedure yields time stepping schemes which dramatically reduce the required computational effort, compared to schemes based on the full vector field.

After a brief introduction to the concept of splitting and the non-stiff convergence theory, we concentrate on problems with unbounded operators. It turns out that the non-stiff order conditions are sufficient to get optimal convergence orders for exponential splitting methods in the stiff case. We discuss analytic frameworks for proving (optimal) convergence results, and we introduce a new setting that is applicable for a wide variety of linear equations and their dimension splittings. In particular, we analyse parabolic problems with homogeneous Dirichlet or Neumann boundary conditions on bounded domains.

We further discuss a new class of splitting methods of orders up to fourteen based on complex coefficients. These results resolve the open question whether there exist splitting schemes with convergence rates greater than two in the context of analytic semigroups. As a concrete application we consider once more parabolic equations and their dimension splittings. The sharpness of our theoretical error bounds is illustrated by numerical experiments.

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