Overcoming order reduction in diffusion-reaction splitting

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For diffusion-reaction equations employing a splitting procedure is attractive as it reduces the computational demand and facilitates a parallel implementation. Moreover, it opens up the possibility to construct second-order integrators that preserve positivity independent of the time step size used. However, for boundary conditions that are neither periodic nor of homogeneous Dirichlet type order reduction limits its usefulness. In the situation described the Strang splitting procedure is no more accurate than Lie splitting.

In this talk, we introduce a modified Lie/Strang splitting procedure that, while retaining all the favorable properties of the original method, does not suffer from order reduction. That is, the modified Strang splitting is second order accurate in time. Furthermore, for time independent boundary conditions the required modification can be precomputed and thus no additional computational cost is incurred.

We demonstrate our results by presenting numerical simulations in one and two space dimensions with inhomogeneous and time-dependent Dirichlet boundary conditions. In addition, a mathematically rigorous convergence analysis is presented that explains the results observed in the numerical simulations.

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