

TEMPLE UNIVERSITY
Department of Mathematics

Applied Mathematics and Scientific Computing Seminar

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Order Reduction in Runge-Kutta Methods for Initial Boundary Value Problems

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Abstract.

When advancing a time-dependent PDE forward via Runge-Kutta methods, one may observe a convergence order that is less than the actual order of the scheme. We demonstrate that this order reduction phenomenon is in fact the norm, and not the exception. Geometrically, it stems from boundary layers, produced by the fact that the scheme is too accurate near the boundary. A modal analysis reveals under which circumstances boundary layers persist over many time steps. Moreover, we provide two remedies that overcome order reduction: (1) a new conditions on the Butcher tableau, called weak stage order, which is compatible with diagonally implicit Runge-Kutta schemes; (2) a systematic derivation of modified boundary conditions.