On Global Error Estimation and Control for Stiff Initial Value Problems

Jens Lang (Technische Universität Darmstadt), Alexander Rath

In [1] we have studied a classical global error estimation based on the first variational equation, and global error control, for which we have used the property of tolerance proportionality. We have found, using the linearly implicit Runge-Kutta-Rosenbrock method ROS3P as example integrator, that the classical approach is remarkably reliable. For parabolic PDEs, the ODE approach is combined with estimates for the spatial truncation errors based on Richardson extrapolation [2].

In spite of the fact that the asymptotic theory behind the first variational equation is classical in the sense that stiffness is not taken into account, the approach works also successfully for stiff equations. This gave us the motivation to derive global error estimates in the framework of B-convergence, where a one-sided Lipschitz condition is assumed. We will present first results for one-step methods of order $p \leq 3$.

[1] J. Lang, J. Verwer, On Global Error Estimation and Control for Initial Value Problems, SIAM J. Sci. Comput. 29, pp. 1460-1475, 2007.

[2] K. Debrabant, J. Lang, On asymptotic global error estimation and control of finite difference solutions for semilinear parabolic equations, Computer Methods in Applied Mechanics and Engineering 288, pp. 110-126, 2015.