Stability of Patankar-type schemes
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Higher-order time integration methods that unconditionally preserve positivity and linear invariants of the underlying ODE system cannot belong to the class of general linear methods. This poses a major challenge for the stability analysis of such methods since the approximation on the next time level depends nonlinearly on the current iterate. Moreover, for linear systems, the existence of linear invariants is always associated with zero eigenvalues, so that steady states of the continuous problem become non-hyperbolic fixed points of the numerical time integrator. Altogether, the stability analysis of such methods requires the investigation of non-hyperbolic fixed points for general nonlinear iterations.

This talk presents a theorem, based on the center manifold theory for maps, that allows to study the stability of non-hyperbolic fixed points of one-step methods. The theorem provides sufficient conditions for the stability of the method as well as the local convergence to the correct steady state. Furthermore, stability properties of MPRK, SSP-MPRK, BBKS and GeCo schemes will be discussed.