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Multirate Runge–Kutta schemes for advection equations. - Journal of Computational and Applied Mathematics **226**(2009)345–357. - doi:10.1016/j.cam.2008.08.009.

Abstract. Explicit time integration methods can be employed to simulate a broad spectrum of physical phenomena. The wide range of scales encountered lead to the problem that the fastest cell of the simulation dictates the global time step. Multirate time integration methods can be employed to alter the time step locally so that slower components take longer and fewer time steps, resulting in a moderate to substantial reduction of the computational cost, depending on the scenario to simulate [S. Osher, R. Sanders: Numerical approximations to nonlinear conservation laws with locally varying time and space grids. - *Math. Comput.* **41**(1983)321–336; H. Tang, G. Warnecke: A class of high resolution schemes for hyperbolic conservation laws and convection-diffusion equations with varying time and space grids. - *SIAM J. Sci. Comput.* **26**(4)(2005)1415–1431; E. Constantinescu, A. Sandu: Multirate timestepping methods for hyperbolic conservation laws. - *SIAM J. Sci. Comput.* **33**(3)(2007)239–278]. In air pollution modeling the advection part is usually integrated explicitly in time, where the time step is constrained by a locally varying Courant–Friedrichs–Lewy (CFL) number. Multirate schemes are a useful tool to decouple different physical regions so that this constraint becomes a local instead of a global restriction. Therefore it is of major interest to apply multirate schemes to the advection equation. We introduce a generic recursive multirate Runge–Kutta scheme that can be easily adapted to an arbitrary number of refinement levels. It preserves the linear invariants of the system and is of third order accuracy when applied to certain explicit Runge–Kutta methods as base method.

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