

Numerical properties of mixed order variational integrators applied to dynamical multirate systems

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Dynamical systems having components that act on different time scales are a challenge for numerical integration. Established approaches are to split the potential forces into fast and slow ones or separating the configurations into fast and slow degrees of freedom allowing for different treatment. Embedded in the framework of variationally derived integrators, the idea here is, to use polynomials of different degrees to approximate the components that act on different time scales. Together with quadrature rules of different orders to approximate the parts of the action integral, the discrete Lagrangian is defined. Numerical investigations reveal, that within this approach run-time savings can be achieved while the accuracy stays nearly the same. However, linear stability can suffer, what is shown by analysing the eigenvalues of the propagation matrices. Some of the presented integrators are reformulated as modified trigonometric integrators and the modulated Fourier expansion is used to analyse the capture of the slow energy exchange and the conservation of total energy and stiff oscillatory energy in the Fermi-Pasta-Ulam problem.