A Comparison of Conservative Finite Element Methods for Hamiltonian PDEs on Nonuniform Meshes

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We investigate the construction of conservative methods for Hamiltonian PDEs, a large class of PDEs endowed with physically relevant geometric structures. Namely, these problems conserve an underlying Hamiltonian functional over time. They arise from a variety of areas, not least meteorological, such as the semi-geostrophic equations, and oceanographical, such as Korteweg-de Vries (KdV) type equations and the nonlinear Schrödinger equations. We describe a general methodology for the construction of spatial finite element discretisations which conserve a discrete Hamiltonian functional. Restricting our focus to KdV type equations we present two conservative spatial finite element method, both conserving different nonlinear invariants of the problem. We conduct a numerical comparison of both methods, in particular, examining how various nonuniform meshes effect the qualitative behaviour of the solution.

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