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A variational finite element discretization for compressible fluids

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We present a finite element variational integrator for compressible flows. The numerical scheme is derived by discretizing, in a structure-preserving way, the Lie group formulation of fluid dynamics on diffeomorphism groups and the associated variational principles. Given a triangulation on the fluid domain, the discrete group of diffeomorphisms is defined as a certain subgroup of the group of linear isomorphisms of a finite element space of functions. In this setting, discrete vector fields correspond to a certain subspace of the Lie algebra of this group. This subspace is shown to be isomorphic to a Raviart–Thomas finite element space. The resulting finite element discretization corresponds to a weak form of the compressible fluid equation that does not seem to have been used in the finite element literature. It extends previous work done on incompressible flows and at the lowest order on compressible flows. We illustrate the conservation properties of the scheme with some numerical simulations.

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