Variational and Thermodynamically Consistent Discretization for Heat Conducting Fluids

François J. M. Gay-Balmaz
CNRS Ecole Normale Supérieure, France
francois.gay-balmaz@lmd.ens.fr

We construct a structure-preserving and thermodynamically consistent finite element method and time-stepping scheme for heat conducting viscous fluids. The method is deduced by discretizing a variational formulation for nonequilibrium thermodynamics that extends Hamilton's principle for fluids to systems with irreversible processes. The resulting scheme preserves the balance of energy and mass to machine precision, as well as the second law of thermodynamics, both at the spatially and temporally discrete levels. The method is shown to apply both with insulated and prescribed heat flux boundary conditions, as well as with prescribed temperature boundary conditions.

Joint work with Evan Gawlik (University of Hawaii).