Gradient-robust finite element-finite volume scheme for the compressible Stokes equations

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We consider the steady compressible Navier–Stokes equations formulated in primitive variables: velocity, pressure, and a non-constant density. A barotropic flow is assumed, where the pressure depends solely on the density via an exponential equation of state.

In this talk, we present a numerical scheme for the compressible Stokes equations that couples a finite element discretization for the momentum equation with a finite volume method for the continuity equation, assuming an isentropic equation of state. The scheme ensures stability, mass conservation, positivity of density, and reserves pressure-robustness when the Mach number goes to zero. The latter property is related to the locking phenomenon observed in incompressible flow at high Reynolds number regimes, which carries over to the compressible setting and is addressed using reconstruction onto H(div)-conforming finite element spaces. The scheme's properties are validated through a range of numerical benchmark problems.

References:

[1] https://doi.org/10.1016/j.cma.2020.113069

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