Costa, Gustavo K.; **Lyra, Paulo R. M.**

A stabilized finite element formulation to solve high and low speed flows. (English)

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Summary: It is well known that numerical methods designed to solve the compressible Euler equations, when written in terms of conservation variables, behave poorly in the incompressible limit, that is, when density variations are negligible. However, a change to pressure-based variables seem to, partly, eliminate the problem by making Jacobian matrices fully invertible whatever the flow regime may be. Despite this apparent benefit, the stabilization matrix plus discontinuity capturing operator (for the compressible regime) still need attention, since they tend to be ill behaved for either conservation or pressure variables. In this paper, we introduce a simple way of balancing two stabilizing matrices, one of them suitable for low Mach number flows and the other one for supersonic flows, so that a wide range of flow regimes is covered with only one formulation. Comparison between conservation and pressure variables is made, and numerical examples are shown to validate the method.

MSC:

76M10 Finite element methods applied to problems in fluid mechanics
76N15 Gas dynamics (general theory)

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