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von Neumann Stability Analysis of Numerical Solution Schemes for 1D and 2D Euler Equations SANTOSH KONANGI, NIKHIL KUMAR PALAKURTHI, URMILA GHIA, University of Cincinnati — A von Neumann stability analysis is conducted for numerical schemes for the full system of coupled, density-based 1D and 2D Euler equations, closed by an isentropic equation of state. The governing equations are discretized on a staggered grid, which permits equivalence to finite-volume discretization. Presently, first-order accurate spatial and temporal finite-difference techniques are analyzed. The momentum convection term is treated as explicit, semi-implicit or implicit. Density upwind bias is included in the spatial operator of the continuity equation. By combining the discretization techniques, ten solution schemes are formulated. For each scheme, unstable and stable regimes are identified through the stability analysis, and the maximum allowable CFL number is predicted. The predictions are verified for selected schemes, using the Riemann problem at incompressible and compressible Mach numbers. Very good agreement is obtained between the analytically predicted and "experimentally" observed CFL values for all cases, thereby validating the analysis. The demonstrated analysis provides an accurate indication of stability conditions for the Euler equations, in contrast to the simplistic conditions arising from model equations, such as the wave equation.

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