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NUMERICAL SIMULATION OF SUBSONIC GAS FLOWS USING LOCAL DISCRETE NONREFLECTING BOUNDARY CONDITIONS

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Modeling external problems of subsonic gas dynamics or aeroacoustics faces spurious wave reflections from artificial boundaries. As well known, the multi-dimensional wave equation does not permit local boundary conditions to be transparent for any oblique waves [1]. In fluid dynamics and other fields, alternative and more expensive techniques are applied such as nonlocal boundary conditions and Perfectly Matched Layers (PML).

In this study a new type of local boundary conditions is developed. Finite-difference models of fluid dynamics usually possess additional (singular) modes and require a greater number of equations on boundaries than the continuous models do. Such boundary conditions, known from [2, 3], are intended for the chosen discrete algorithm rather than the differential equations. We analyze and systematize numerical schemes and find boundary formulations resulting in small wave reflections for any angle of incidence.

The theory presented is illustrated with numerical examples both linear and nonlinear, starting from 3-point schemes and arriving in high-order 7-point centered-difference schemes [2] on regular grids and 5-point upwind schemes of EBR (Edge Based Reconstruction) type on unstructured meshes [4].

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