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VISCOUS FLOW CALCULATIONS WITH THE SPECTRAL DIFFERENCE METHOD USING HIGH-ORDER MESHES

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The work explores a variety of aspects related to the practical use of the spectral difference (SD) method. Such aspects encompass limiting methodologies, different numerical viscous flux schemes and high-order mesh generation. Different numerical diffusive flux schemes are addressed in order to solve flux discontinuity across cell interfaces. The aim is to verify the accuracy of all schemes, evaluate their robustness and computational efficiency in term of number of iterations and time required to satisfy a convergence criterion. The methods here considered are the 1st and 2nd approaches by Bassi and Rebay [1], the interior penalty approach and the local spectral difference approach. Variations on ways to calculate terms not defined in these methods are also considered. The numerical experiments are focused on evaluating the schemes across a wide range of Reynolds numbers and their coupling with limiting techniques in order to provide solutions to transonic flows.

Accurate results can only be obtained with high-order numerical schemes if the corresponding high-order curved representation of the boundary is used. Previous work [2] has addressed this issue by creating a methodology that combines a geometry file with its corresponding mesh in order to generate a boundary representation of arbitrary order. Here, the procedure is further extended by using a radial basis function (RBF) technique [3] to properly propagate the deformation generated at the boundary into the interior of the mesh. This approach is additionally improved by combining RBF's with optimization techniques. The overall process avoids invalid elements that may be generated in the curving step, which can be particularly troublesome for highly stretched viscous grids.

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