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A Characteristic-Based Volume Penalization Method for Compressible Viscous Flows in Complex Geometries[1] ERIC BROWN-DYMKOSKI, NURLYBEK KASIMOV, OLEG VASILYEV, University of Colorado at Boulder — This is the first of two talks on new volume penalization method for numerical simulations of compressible flows around solid obstacles of complex geometries. This approach overcomes two major limitations of Brinkman penalization – the inability to model Neumann boundary conditions and shock reflection of solid boundaries. Boundary conditions on the fluxes are achieved through characteristic propagation into the thin layer inside of the obstacles. Inward pointing characteristics ensure nonphysical solution inside the obstacle does not propagate out to the fluid. The Dirichlet boundary conditions are enforced similarly to Brinkman penalization. Parameters defining the penalization terms are chosen so that they act on a much faster timescale than the characteristic time scale of the flow. A principle advantage of this method is the parameters provide a systematic means of controlling the error. The new approach is general and applicable to wide variety of flow regimes. This talk focuses on the application of the method to the Navier-Stokes equations. It is rigorously shown that the solution of the penalized problem converges towards the exact solution with the convergence of the penalization parameters. Examples of application to compressible viscous flows are given and discussed.

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Oleg Vasilyev
University of Colorado at Boulder

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