Energy Stable High-Order Methods for Compressible Viscous Flows
By
David Williams

The flux reconstruction (FR) approach unifies several popular high-order methods for unstructured meshes, including the nodal discontinuous Galerkin (DG) and spectral difference (SD) methods (in the context of linear problems). Recently, Vincent, Castonguay, Williams, and Jameson identified a family of high-order FR schemes which are provably stable for linear advection-diffusion problems in 1D, for all orders of accuracy. This family of FR schemes recovers the collocation-based nodal DG scheme as a special case, and allows for the formulation of new high-order schemes with Courant-Friedrichs-Lewy (CFL) limits which are more than twice those of the collocation-based nodal DG scheme. This family of 1D FR schemes has been successfully applied to both linear and non-linear advection-diffusion problems in 2D and 3D using a tensor product extension to quadrilateral elements (in 2D) and hexahedral elements (in 3D). More recently, Williams, Castonguay, Vincent, and Jameson have extended these schemes to simplex elements in 2D and 3D, proving the stability of a family of FR schemes (for all orders of accuracy) for linear advection-diffusion problems on triangular and tetrahedral grids. This latest development allows, for the first time, the application of a family of provably stable FR schemes to problems on mixed grids of triangular and quadrilateral elements (in 2D) and tetrahedral and hexahedral elements (in 3D). Such grids are of great practical interest, as complex geometric domains are frequently meshed with combinations of simplex and quadrilateral (or hexahedral) elements. In their presentation, the authors will examine the performance of the family of stable FR schemes for mixed grids by using these schemes to solve the linear advection-diffusion equations and the non-linear Navier-Stokes equations on unstructured mixed grids.