

## SHORT ABSTRACT

### **Thesis Title: Regulation of Numerical Diffusion for Compressible-Flow Computations**

This thesis presents a study on the effects of numerical diffusion in the computation of both inviscid and viscous-compressible flows, and developments of new methods for accurate computation of compressible flows through numerical-diffusion regulation. The study revolves around the numerical diffusion associated with the Diffusion-regulated Local-Lax-Friedrichs (DRLLF) scheme. It is shown that the most appropriate level of numerical diffusion of the scheme is problem-dependent and it is to be chosen based on a careful trade-off between accuracy and numerical stability. The study further reveals that the DRLLF scheme resolves grid-inclined weak shocks much better than the conventional flux-vector-splitting (FVS) schemes like van Leer's Flux-Vector Splitting (FVD) and Advection Upstream Splitting Method (AUSM). On the other hand, the conventional upwind schemes are more accurate in resolving grid-aligned strong shocks. Further, it is demonstrated that in the presence of physical viscosity it is indeed possible to improve the accuracy of computations by using lower levels of numerical diffusion with the DRLLF scheme than the original scheme that was designed for inviscid-compressible flows. This finding further inspires the development of a diffusion-regulated version of the DRLLF scheme that produces much accurate results for viscous-flow computations than the original scheme by scaling down the numerical diffusion of the latter using a novel boundary-layer sensor. The improved version of the DRLLF scheme, which is particularly designed for accurate computations of viscous-compressible flows is named the DRLLF-Viscous (DRLLFV) scheme. Finally, the complimentary performances of the AUSM and DRLLF schemes in resolving grid-aligned strong and grid-inclined weak shocks are exploited by developing a self-adjusting-hybrid scheme for inviscid-flow computations that combines the two schemes using a new shock switch. This new scheme is termed the AUSM-DRLLF Self-Adjusting Hybrid (ADSAH) schemes. For viscous-flow computations the hybrid framework combines the AUSM and DRLLFV schemes. The scheme is named as AUSM DRLLF Self-adjusting Hybrid-Viscous (ADSAHV) scheme. The accuracy, robustness and versatility of the new hybrid approach are demonstrated through a wide range of test problems on inviscid and viscous-compressible flows.