Simulations of Turbulent Flows with Strong Shocks and Density Variations
A. Bhagatwala, B. Morgan, B. Olson, S. K. Shankar, and S. K. Lele

Introduction

- The Unsteady Flow Physics and Aeroacoustics Laboratory at Stanford University is a research group in the Department of Aeronautics and Astronautics directed by Dr. Sanjiva K. Lele.
- Unsteady flow physics are difficult to accurately capture with Reynolds Averaged Navier Stokes (RANS) Solvers.
- High-fidelity simulations help us quantify modeling errors and guide improved reduced order models.

Purpose and Hypothesis

Motivation and objectives

- Shock wave interaction with turbulence and sharp density gradients is a common phenomenon arising widely in various areas of science and technology such as cosmic science (supernova explosion), energy technology (inertial confinement fusion), medical application (shock wave lithotripsy) and perhaps most obviously in supersonic flight (shock/boundary layer interaction).

Approach

- High-order compressible Navier-Stokes solver on structured mesh.
- Localized Artificial Diffusivity (LAD) for shock capturing with dilatation-based switching function

Current Work

- Improve the numerical methods to capture unresolved discontinuities with minimum numerical dissipation
- Advance the understanding of interactions between shocks and turbulent boundary layers and other turbulent mixing layers.

Conclusions

RANS models often do not accurately capture unsteady flow physics, particularly in high-speed turbulent flows where such unsteady phenomena are commonplace. DNS and LES naturally capture the turbulence dynamics associated with energetic scales. Using the data collected from high fidelity simulations, we hope to better understand the limitations of RANS models and suggest improvements.

References


Further Information

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