



Instabilities Driven Reacting Compressible Turbulence

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Abstract

Petascale computing is expected to bring a number of breakthroughs in science. One of the areas most likely to benefit is fluid turbulence, where very large scale computations can bring the insight and indicate the appropriate modeling paradigms for the routine coarse mesh calculations needed in applications. Rigorous modeling techniques for the unclosed or sub-grid terms are essential to facilitate the use of these low resolution calculations in science-based prediction. Large scale simulations of canonical incompressible turbulent flows have been performed and advanced our understanding of the turbulence phenomena. As a result, several modeling approaches now work reasonably well for coarse mesh simulations of these simple flows, even though a complete parametrization of turbulence still eludes us. In many important applications, however, fluid turbulence is accompanied by complicating physics: compressibility, exothermic reactions, differential accelerations. In many situations such flows occur in convergent geometries (e.g., cylindrical or spherical). Examples include Inertial Confinement Fusion targets, laser induced launching of a flyer plate, stellar pulsations, or supernova explosions. Fundamental turbulence studies and high resolution simulations of these flows have not been performed and the appropriate modeling paradigms are not known. We propose to perform the first Direct Numerical Simulations of instabilities driven reacting compressible turbulence in Cartesian and spherical coordinates. We want to find the changes in the turbulence characteristics compared to canonical conditions and the appropriate modeling paradigms for such flows. We will perform reacting simulations that are relevant to thermonuclear burning in Type I X-ray bursts and Type Ia supernovae.