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A Multiscale Morphing Continuum Description for Turbulence

JAMES CHEN, LOUIS WONNELL, Kansas State Univ — Turbulence is a flow physics phenomena invlolving multiple length scales. The popular Navier- Stokes equations only possess one length/time scale. Therefore, extremely fine mesh is needed for DNS attempting to resolve the small scale motion, which comes with a burden of excessive computational cost. For practical application with complex geometries, the research society rely on RANS and LES, which requre turbulence model or subgrid scale (SGS) model for closure problems. Different models not only lead to different results but usually are invalidated on solid physical grounds, such as objectivity and entropy principle.The Morphing Continuum Theory (MCT) is a high-order continuum theory formulated under the framework of thermalmechanics for physics phenomena involving microstructure. In this study, a theoretical perspective for the multiscale nature of the Morphing Continuum Theory is connected with the multiscale nature of turbulence physics. The kinematics, balance laws, constitutive equations and a Morphing Continuum description of turbulence are introduced. The equations were numerically implemented for a zero pressure gradient flat plate. The simulations are compate with the laminar, transitional and turbulence cases.

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