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Speaker: Dr. Fernando F. Grinstein
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Title: "On implicit LES for turbulent flows"

Abstract

Large Eddy Simulation (LES) is an effective intermediate approach between DNS and RANS, capable of simulating flow features which cannot be handled with RANS such as significant flow unsteadiness and strong vortex-acoustic couplings, and providing higher accuracy than RANS at reasonable cost but still typically an order of magnitude more expensive. In the absence of an accepted universal theory of turbulence, the development and improvement of subgrid scale (SGS) models has been unavoidably pragmatic and based on the rational use of empirical information. Classical approaches have included many proposals ranging from, inherently-limited eddy-viscosity formulations, to more sophisticated and accurate mixed models, e.g., [1]. Their main drawback relates to the fact that well-resolved (discretization-independent) LES becomes prohibitively expensive for the practical flows of interest at moderate-to-high Re.

In the Implicit LES (ILES) approach the proposal is to focus on two distinct physical SGS features to be emulated near the resolution cutoff: the inherent small-scale anisotropy in the high-wave number end of the inertial subrange region (worm vortices), and the inherently discrete nature of laboratory observables (finite space/time scales). We are thus led to propose that ILES be based on Finite Volume (FV) non-oscillatory numerics adaptive to the local flow physics (sharp velocity-gradient capturing capability at smallest resolved scales).

In the MILES approach (see [2] for a recent review), the effects of the SGS physics on the resolved scales are incorporated in the functional reconstruction of the convective fluxes using monotonicity-preserving FV methods. Tests in fundamental applications ranging from canonical to complex flows indicate that MILES is competitive with conventional LES in the LES realm proper (i.e., for flows driven by large scale features). Use of the modified LES equation as a framework for theoretical ILES analysis, suggests that the leading discretization error terms introduced by Non-Oscillatory FV schemes provide implicit SGS models of mixed anisotropic type [2] as well as regularized motion of discrete observables [3]. An overview of recent progress with ILES will be presented; outlook and challenges will be addressed in this context.