RECONCILING PHYSICAL FIDELITY, ROBUSTNESS AND EFFICIENCY IN COMPUTATIONAL FLUID DYNAMICS

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ABSTRACT

Over the last decades, Computational Fluid Dynamics (CFD) has become a widespread research and design tool in many fields of enormous societal impact, including biomedicine and renewable energies, among others – either alone, or as part of broader (coupled) multi-physics models. The driving force behind this growth is the continuous progress of high performance computing (HPC) systems, in conjunction with the development of more and more efficient numerical techniques and physics-based turbulence models. Furthermore, the quest for increasingly detailed results in multiple fields (e.g. precision manufacturing, personalized medicine, etc.), and the cost/difficulties associated with experimental campaigns, are pushing the CFD community towards enabling predictive eddy-resolving simulations of complex flows in fast turnaround times. This paradigm shift requires a wise combination of numerical robustness, physical fidelity and algorithmic efficiency, a set of conflicting requirements that continues to thrill developers and practitioners alike.

This mini-symposium aims at providing a forum to discuss current challenges in CFD towards the solution of increasingly complex multi-scale and multi-physics problems, with a particular focus on (but not limited to) the following three interconnected areas:

- *physical fidelity:* physics-compatible numerical methods (e.g. invariant-preserving schemes), physics-inspired implicit/explicit large-eddy simulation (LES) models, and the application of these approaches in scenarios of industrial or biological interest;

- *numerical robustness:* traditional stabilization strategies (e.g., numerical dissipation, filtering, etc.) vs. physics-compatible approaches; algorithms for complex geometries (e.g. unstructured vs. Cartesian immersed-boundary methods);

- *algorithmic efficiency*: low- vs high-order spatial/temporal methods, wall modeling, efficient time stepping (explicit vs. implicit), reducing the memory bandwidth and operation count of numerical schemes, adaptive mesh refinement strategies.

Contributions focusing on open-source implementations are also especially welcome.