Università degli Studi di Udine

Dottorato di Ricerca in Scienze dell'Ingegneria Energetica e Ambientale

Seminari del Corso di Dottorato

# Physics-Inspired Coarsening for Large-Eddy Simulation of Turbulent Flows


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**Abstract:** Large-eddy simulation (LES) is widely used for computing high Reynolds number turbulent flows. LES is typically framed in terms of solving the spatially-filtered Navier-Stokes equation, but the use of spatial filtering for LES is not without its shortcomings. Issues include: (i) how to define filtering for wall-bounded flows, (ii) commutation errors for non-uniform filters, and (iii) extensibility to flows with additional complexity, such as multiphase flows. While it is sometimes possible to ignore these issues in practice, the emergence of data-driven modeling techniques, with the necessity of training data, amplifies the need for a robust, comprehensive coarsening framework for LES that improves upon spatial filtering. In this presentation, I will review turbulence theory relevant to LES, most notably, the kinetic energy cascade. Physics-inspired coarsening will be introduced as a new perspective that leads to novel physical insight into energy cascade dynamics. Furthermore, it provides a generalizable procedure for LES theory that can address the aforementioned weaknesses of spatial filtering. Some preliminary modeling results, including a generalizable dynamic procedure that does not require a test filter, will be shown to demonstrate the feasibility of this new approach to LES.


**CV**: Perry Johnson earned his Ph.D. in 2017 from Johns Hopkins University (advisor: Charles Meneveau), where his work on velocity gradient dynamics in turbulence won the Corrsin-Kovasznay award. He was then a postdoctoral fellow at the Center for Turbulence Research at Stanford University for three years, working on various topics related to the turbulence energy cascade, turbulent multiphase flows, and turbulent boundary layers. In 2020, he joined the Mechanical and Aerospace Engineering department at the University of California, Irvine as an assistant professor. His research on the energy cascade was featured in the April 2021 issue of *Physics Today*.