LadHyX Seminar — March 5, 10:45

Taraneh Le Chanadec
(Illinois U.)

Optimization and control of complex flows using adjoint-based methods

Numerical simulations of multiphysics and multiscale phenomena in fluid mechanics have advanced remarkably over the past decades. Complex physical processes, including among others multiphase flows, combustion and acoustics problems, and turbulent and thermal flows, can now be simulated with an astonishing degree of fidelity and accuracy. In spite of these advances, specifically with regards to more complex flows, modeling and simulation technologies remain at the stage of observation, reproduction, and prediction. However, optimization and control of such flows, by enhanced designs or active control strategies, is crucial for improvements in performance and robustness, and is necessary for venturing beyond standard operating conditions. The transition from model-based numerical solvers to model-based design and optimal control requires additional technology that enables relatively easy access to “inverse" information or backward solution. To date, this information has only been extracted from simulations of simplified configurations with additional unrealistic assumptions. In related fields (aero-dynamics, aero-acoustics), inverse optimization and control have improved airfoil shapes and reduced noise levels. Complex flows, including combustion or interfaces, however, constitute a far larger step in complexity, due to the presence of unsteadiness and nonlinearities, and therefore, require advanced techniques such as adjoint-based optimization. Throughout this talk we will first introduce an adjoint-based algorithm suitable for complex flow configurations, and then provide examples of reactive and interfacial flows where this algorithm has been implemented.