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AQUARIUS Team : Numerical Methods for Uncertainty Quantification and Prediction of high Reynolds number Flows

Title : Innovative Contributions and work in progress for quantifying uncertainties in fluid flow problems.

Abstract :
This research project deals with uncertainty quantification and numerical simulation of high Reynolds number flows. It represents a challenging study demanding accurate and efficient numerical methods. It involves the INRIA team BACCHUS, FRG group from the Department of Aeronautics and Astronautics and the UQ Lab from the Department of Mechanical Engineering at Stanford University. The first topic concerns the simulation of flows when only partial information about the physics or the simulation conditions (initial conditions, boundary conditions) is available. In particular we are interested in developing methods to be used in complex flows where the uncertainties represented as random variables can have arbitrary probability density functions. The second topic focuses on the accurate and efficient simulation of high Reynolds number flows. Two different approaches are developed (one relying on the XFEM technology, and one on the Discontinuous Enrichment Method (DEM), with the coupling based on Lagrange multipliers). The purpose of the proposed project is twofold : i) to conduct a critical comparison of the approaches of the two groups (Stanford and INRIA) on each topic in order to create a synergy which will lead to improving the status of our individual research efforts in these areas ; ii) to apply improved methods to realistic problems in high Reynolds number flow.
In this talk, we will illustrate some recent results obtained in the context of uncertainty quantification and of the Discontinuous Enrichment Method. First, we will briefly describe the Simplex^2 method, that is an innovative technique developed in AQUARIUS for robust design optimization and for treating epistemic uncertainties. Then, new perspectives for the computation of high-order statistics will be drawn and the impact of building a new numerical platform for stochastic computations will be investigated. Finally, last developments and future works in Discontinuous Enrichment Method will be presented.