Seminar 2022

Math

Quasi-Monte Carlo finite element approximation of the Navier-Stokes equations with initial data modeled by log-normal random fields

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Abstract: In this talk, we analyze the numerical approximation of the Navier-Stokes problem over a bounded polygonal domain in R^2, where the initial condition is modeled by a log-normal random field. This problem usually arises in the area of uncertainty quantification. We aim to compute the expectation value of linear functionals of the solution to the Navier-Stokes equations and perform a rigorous error analysis for the problem. In particular, our method includes the finite element, fully-discrete discretizations, truncated Karhunen-Loéve expansion for the realizations of the initial condition, and lattice-based quasi-Monte Carlo (QMC) method to estimate the expected values over the parameter space. Our QMC analysis is based on randomly-shifted lattice rules for the integration over the domain in high-dimensional space, which guarantees the error decays with $O(N^{-1+\delta})$, where N is the number of sampling points, $\delta > 0$ is an arbitrary small number, and the constant in the decay estimate is independent of the dimension of integration.

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