

Quantum Information *Seminar Series*

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Quantum Information Seminar 2026

Friday, October 23 | 12:00pm - 1:00pm, IRCB Room 1030

Questions? Contact: Wei Guo

Towards Quantum-Based Homogenized Multiscale Simulation of Turbulent Flows

Abstract: Quantum computers can encode vast flow fields in remarkably few qubits, yet the equations of fluid motion are nonlinear, dissipative, and multiscale, while quantum operations are linear and unitary. Bridging this mismatch is the central challenge in bringing turbulence to quantum machines. In this talk, I will present a step-by-step pathway toward that goal. We begin with linear transport and show that advection with a spatially varying velocity, viscous diffusion, and continuous forcing can be simulated by a compact hybrid quantum-classical algorithm requiring only a single additional qubit. We then address nonlinearity: a homotopy-based formulation recasts nonlinear flow dynamics as an ordered sequence of linear problems that can be evolved on quantum registers, while tensor-network simulations of two-dimensional Navier-Stokes flow reveal that turbulent fields admit highly compressed, quantum-compatible representations. Finally, we will revisit homogenization-based turbulence modeling and present our multiscale extension, in which the subgrid closure is obtained from small, independent, linear cell problems that can be compressed and solved with quantum algorithms. Together, these advances chart a practical route in which classical high-performance computing and quantum algorithms work in concert to simulate complex flows.



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