Professur für Thermofluiddynamik

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Solving nonlinear differential equations with quantum computers

With all the current advancements in the computational power of classical computers, simulating real-world practical problems still requires immense computational power and energy demands. Quantum computing provides a potential pathway to simulate these problems more efficiently. In this talk, we will look at some recently proposed methods for simulating nonlinear problems using quantum computers. The primary difficulty in solving nonlinear differential equations on quantum computers arises from the inherently linear and unitary nature of quantum mechanics. To solve nonlinear problems with quantum computers, one approach is to transform a nonlinear differential equation into a linear partial differential equation (PDE) and integrate it with quantum algorithms directly. The key to the method is the Fokker-Planck equation, which is a linear partial differential equation. An alternative approach, which will be the main focus of this talk, is to use quantum machine learning methods such as recurrence-free quantum reservoir computers, which have been shown to learn and predict nonlinear chaotic dynamics and extreme events more efficiently on near-term quantum computers in the presence of noise. Starting from a brief introduction of quantum computing, we will go through some working principles of quantum reservoir computing by drawing concepts from dynamical systems theory, such as generalized synchronization of coupled chaotic systems.