FUDAN UNIVERSITY 1905 復旦大學 FUDAN UNIVERSITY

Applied Math Ph.D. Seminar

Time complexity analysis of quantum algorithms via linear representations for nonlinear ordinary and partial differential equations

Speaker: Yue Yu (SJTU)

Time: 2022-11-10, 16:10 to 17:00

Location: Tencent Meeting ID 526-3788-4054

Mentor: Shi Jin (SJTU)

Abstract: We construct quantum algorithms to compute the solution and/or physical observables of nonlinear ordinary differential equations (ODEs) and nonlinear Hamilton-Jacobi equations (HJE) via linear representations or exact mappings between nonlinear ODEs/HJE and linear partial differential equations (the Liouville equation and the Koopman-von Neumann equation). The connection between the linear representations and the original nonlinear system is established through the Dirac delta function or the level set mechanism. We compare the quantum linear systems algorithms based methods and the quantum simulation methods arising from different numerical approximations, including the finite difference discretisations and the Fourier spectral discretisations for the two different linear representations, with the result showing that the quantum simulation methods usually give the best performance in time complexity. We also propose the Schrödinger framework to solve the Liouville equation for the HJE with the Hamiltonian formulation of classical mechanics, since it can be recast as the semiclassical limit of the Wigner transform of the Schrödinger equation. Comparison between the Schrödinger and the Liouville framework will also be made.