Quantum simulation of various non-Hermitian systems

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We investigate general NH systems, using the linear combination of unitaries (LCU) in the scheme of duality quantum computing[1] and the unitary expansion (UE) techniques. We utilize the linear combination of unitaries technique for nonunitary dynamics on a single qubit to give explicit decompositions of the necessary unitaries, and simulate arbitrary time-dependent single-qubit nonunitary operator F(t) using duality quantum algorithm. We find that the success probability is not only decided by F(t) and the initial state, but also is inversely proportional to the dimensions of the used ancillary Hilbert subspace. In a general case, the simulation can be achieved in both eight- and six-dimensional Hilbert spaces. In phase matching conditions, F(t) can be simulated by only two qubits. We illustrate our method by simulating typical non-Hermitian systems and single-qubit measurements. We investigate a novel NH quantum system of PT-arbitrary-phase, pseudo-Hermitian- ϕ-symmetric and τ-anti-pseudo-Hermitian. We optimize the quantum circuits and calculate the success probabilities.

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