# Noise Characterization and Utilization on IBM-Q Superconducting Quantum Computers

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Quantum computing has promised revolutionary means to solve problems in fields such as quantum chemistry, material design, finance, and industrial managements, yet the high error rate in nowadays near-term noisy intermediate-scale quantum (NISQ) computers has so far rendered these breakthroughs elusive. In this talk, I will show the audiences that by detailed understanding of the noise characteristics, we can instead use a noise quantum computer to simulate open quantum system dynamics. Specifically, we propose a novel scheme to utilize intrinsic gate errors of NISQ devices to enable controllable simulation of excitation energy transfer dynamics in a photosynthetic dimer system without ancillary qubits or explicit bath engineering, thus turning unwanted quantum noises into useful quantum resources. To demonstrate that this scheme is realizable, we investigated noise characteristics of superconducting qubits on IBM-Q cloud systems, and simulated energy transfer process on IBM-Q based on the results. By employing tailored decoherence-inducing gates, we show that quantum dissipative dynamics can be simulated efficiently across coherent-to-incoherent regimes with results comparable to those of the numerically-exact classical method. Moreover, we demonstrate a calibration routine that enables consistent and predictive simulations of open-quantum system dynamics in the intermediate coupling regime. It is clear that quantum simulation represents the most promising quantum application to demonstrate quantum advantage on, yet available quantum simulation algorithms are prone to errors and thus difficult to be realized. Our work thus provides a new direction for quantum advantage in the NISQ era.

**References**

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