Quantum Simulation of Driven Dissipative Dynamics with Trapped Ions

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Quantum simulation of a many-particle system amounts to realizing both coherent Hamiltonian time evolution as well as dissipative open-system dynamics due to the controlled coupling of the system to an environment. We introduce a scheme for digital open-system quantum simulation with trapped ions, where quantum gates in combination with optical pumping as a dissipative ingredient enable the engineering of sequences of coherent and dissipative Kraus maps. On the one hand, we show how tailored dissipative maps can be harnessed for dissipative preparation of different types of entangled states. On the other hand, the possibility to combine coherent and dissipative processes gives rise to new types of non-equilibrium dynamics in driven dissipative many-body quantum systems. We discuss recent results from quantum simulation experiments, where such dynamics have been observed with up to five ions.